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THE IMPACT OF CATTLE FEEDLOT  
OPERATION ON GROUNDWATER  
QUALITY IN THE FRACTURED  
ROCKS NEAR THE WIARTON  
SEWAGE LAGOON

August 1978

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THE ONTARIO MINISTRY OF THE ENVIRONMENT

THE IMPACT OF CATTLE FEEDLOT OPERATION  
ON GROUNDWATER QUALITY  
IN THE FRACTURED ROCKS NEAR THE  
WIARTON SEWAGE LAGOON

by  
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SOUTHWESTERN REGION  
TECHNICAL SUPPORT SECTION  
LONDON

August, 1978.

None yet e'er drank a honey'd draught  
Unmixed with cup of bitter gall,  
And cup of gall for honey equally doth call  
That so, the mixture one may easier drink.

Petar Petrović - Njegoš (1813-1851)  
in "The Mountain Wreath"

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## ABSTRACT

Initial complaints by a local resident on the outskirts of the Town of Wiarton were received in late 1975 alleging that the Wiarton sewage lagoon was leaking and thus affecting a spring used for domestic water supply. This complaint was followed by several other complaints by local residents alleging that a large feedlot operation was affecting water quality in their water supplies. This report documents the investigations carried out by staff of the Ministry of the Environment, Southwestern Region, into these complaints.

Domestic water supplies in the area of investigation are obtained from: (i) the shallow dolomite bedrock by means of springs, or shallow wells, and (ii) from deeper wells completed into the shale. Since the overburden averages only 0.5 to 1.5 m in thickness in the problem area, the groundwater in the shallow bedrock is especially vulnerable to any pollutant originating at, or near ground surface.

Potential pollution sources including sewage lagoon effluent, feedlot runoff and surface runoff from cattle grazing areas were sampled and analyzed for various chemical parameters and for bacteriological quality as were the various water supply sources. These results have been presented in various modes, then compared and analysed.

Of the several potential pollution sources which were identified, runoff from feedlots and from cattle grazing areas, and the subsurface disposal of individual domestic

wastes are considered to be the main contributors to the groundwater quality deterioration noted in the Armstrong and Boulter springs. While pollutants from all three sources have been identified in water supplies, runoff from the feedlot and the grazing areas should be considered to be the most serious inputs.

The quality and quantity of runoff originating from feedlot and grazing areas require that it be controlled to prevent groundwater and surface water contamination. The types of control measures employed must protect water quality and at the same time must be readily implementable and economically realistic.

## INTRODUCTION

This report summarizes an investigation into several domestic water supply pollution complaints near the Town of Wiarton, Ontario. It is a more detailed discussion of the preliminary assessment of the same problem previously reported by the writer in 1977.

### Location

The area of investigation is centered along Elm Street in the southeast portion of the Town of Wiarton and along the road between Concessions XXI and XXII in Keppel Township.

The study area is shown in Figure 1 and includes about 4 sq km. The identification of sampling points is indicated in Figure 1 and in Appendix A.

Access to the study area is along Elm Street which intersects Provincial Highway 6.

### Background

Complaints of domestic water supply contamination were first reported to the Owen Sound District Office of the Ontario Ministry of the Environment (MOE) by local residents (Mrs. G. Armstrong and Miss V. Baker) in November, 1975 and in the early months of 1976. They felt that the sewage

lagoon owned and operated by the Ontario Ministry of the Environment was leaking and was therefore responsible for the deterioration of the water quality in their spring which they use for domestic water supply purposes.

Later, during the summer of 1976, complaints of the same nature were received from other local residents including Mr. Hurlburt, Mr. B. Keith, Mrs. J. Symon and Mr. R. Boulter. These residents suggested that a possible source of contamination of their domestic water supplies was the cattle feedlot owned and operated by Mr. A. Ward. Following these additional complaints, the writer was requested to carry out a groundwater investigation. Therefore all pertinent information already collected by the staff of the Owen Sound District Office was forwarded to the writer in November, 1976.

#### Drainage and Topography

Three local physiographic units are present within the study area: (i) a very gently northwesterly sloping area at the top of the escarpment, (ii) a steep to vertical (up to 15 m high) portion of the escarpment, and (iii) a moderately sloping area below the escarpment.

Surface drainage on the top of the escarpment is poorly developed indicating direct infiltration into the fractured dolomite. Only during the spring snow melt and intensive rainfall in the autumn does surface runoff occur resulting in several minor intermittent "streams" which,

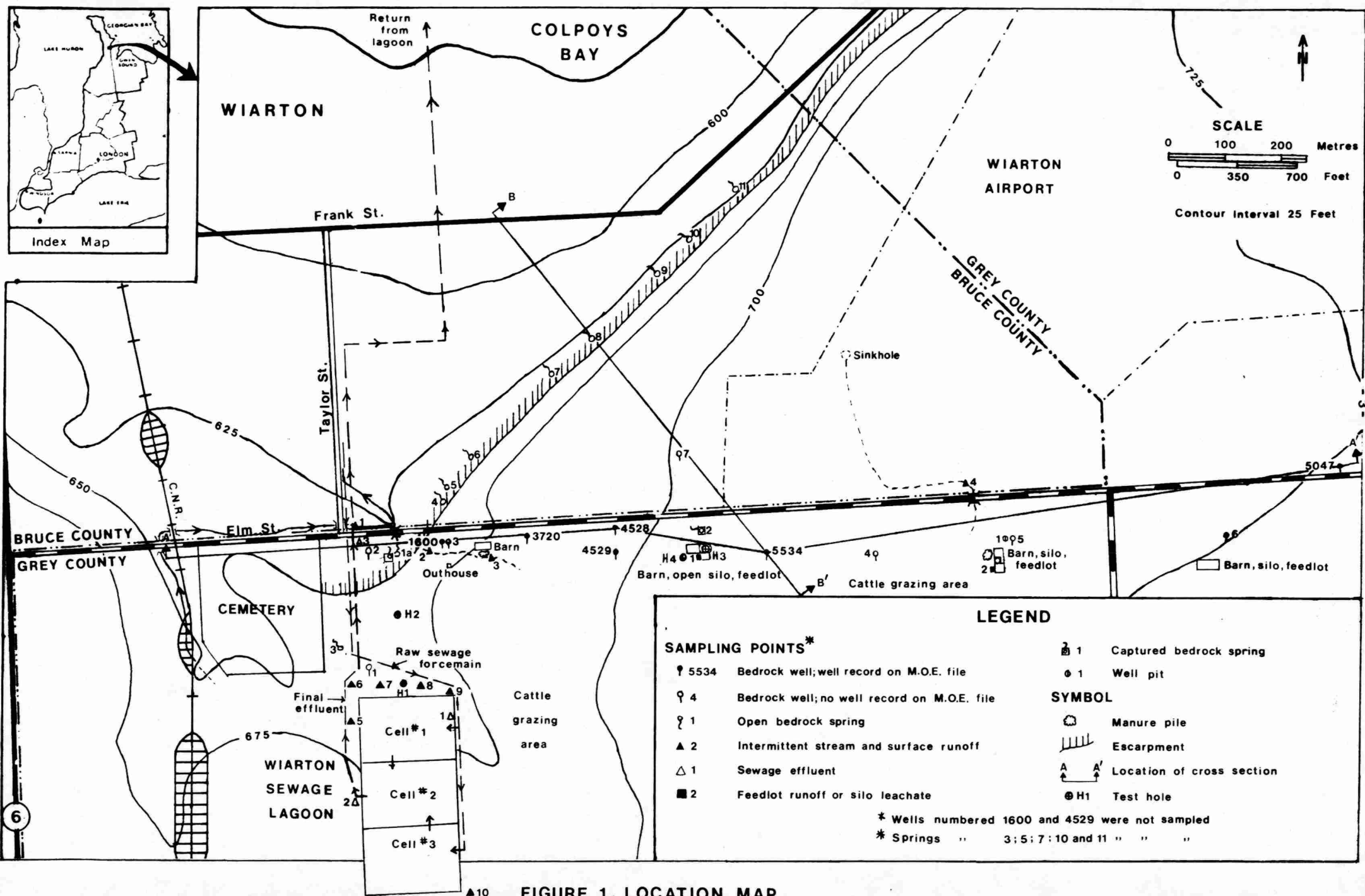


FIGURE 1. LOCATION MAP.

after several hundred meters of surface flow, disappear into small sinkholes. These lost streams remain in the subsurface only briefly and reappear at the toe of the escarpment. In the northwestern section of the study area where the overburden is relatively thick a "diffuse" spring gives rise to a permanent stream.

#### Field Work

This investigation commenced in late November of 1975 and it was initially carried out by William Currie, Larry Struthers and Philip Bye, all of the Owen Sound District Office of the MOE. The writer became involved in November, 1976.

Field work included (i) the examination of local geology and hydrogeology, (ii) the collection of numerous water samples from domestic wells, springs and surface water runoff, (iii) the identification, examination and sampling of potential pollution sources, and the examination of their significance relative to domestic wells and springs, and (iv) the inspection of domestic wells and springs. It also included interviews with local residents whose domestic water supplies were affected.

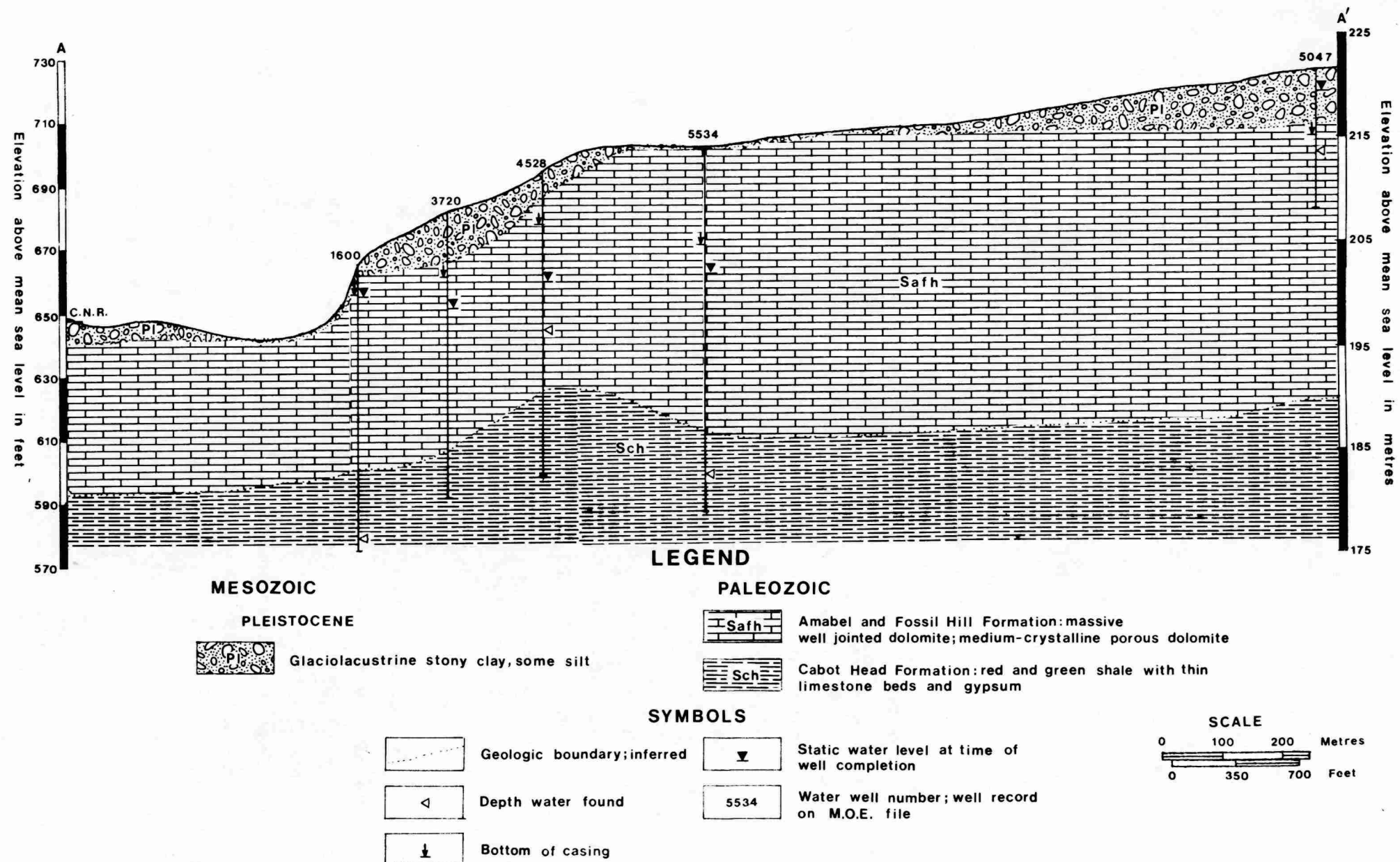


FIGURE 2. VERTICAL CROSS - SECTION A-A' SHOWING GEOLOGY AND HYDROGEOLOGY OF THE STUDY AREA.

Section location is shown in Figure 1.

## GEOLOGY AND HYDROGEOLOGY

### Bedrock Formations

There are many bedrock outcrops in the study area, but the bedrock is best exposed along the escarpment. Bedrock formations within the study area are of Lower and Middle Silurian Age and include the Cabot Head, Amabel and Fossil Hill Formations (Liberty, 1966).

Figures 2 and 3 indicate the distribution of lithologic units in the study area. Several local domestic wells report water from the Cabot Head Formation (Appendix A) which consists of soft, red, and green shale with thin limestone and gypsum beds. Generally, water from this formation is of poor quality (very hard) containing increased concentrations of sodium, chloride, sulphate and potassium. Overlying this formation are the Amabel and Fossil Hill Formations which consist of massive and bedded, well jointed, medium crystalline, porous dolomite (Plate 1). Several small sinkholes are developed in these formations (Plate 2). Several domestic wells in the area obtain water from the upper portion of this lithologic unit (Appendix A, Figures 2 and 3) and two springs (used for water supply) originate in this shallow bedrock aquifer. Spring 1 (Plate 3) serves the domestic requirements of Mrs. G. Armstrong and Miss V. Baker and spring 2 (Plate 4; owned by Mr. R. Boulter) is used for stock watering purposes. Numerous other springs occur along the toe of the Niagara Escarpment (Figure 1) forming a "spring line" which probably marks the contact between the dolomites (Amabel and Fossil Hill Formations) and the poorly permeable underlying shales (Cabot Head Formation).

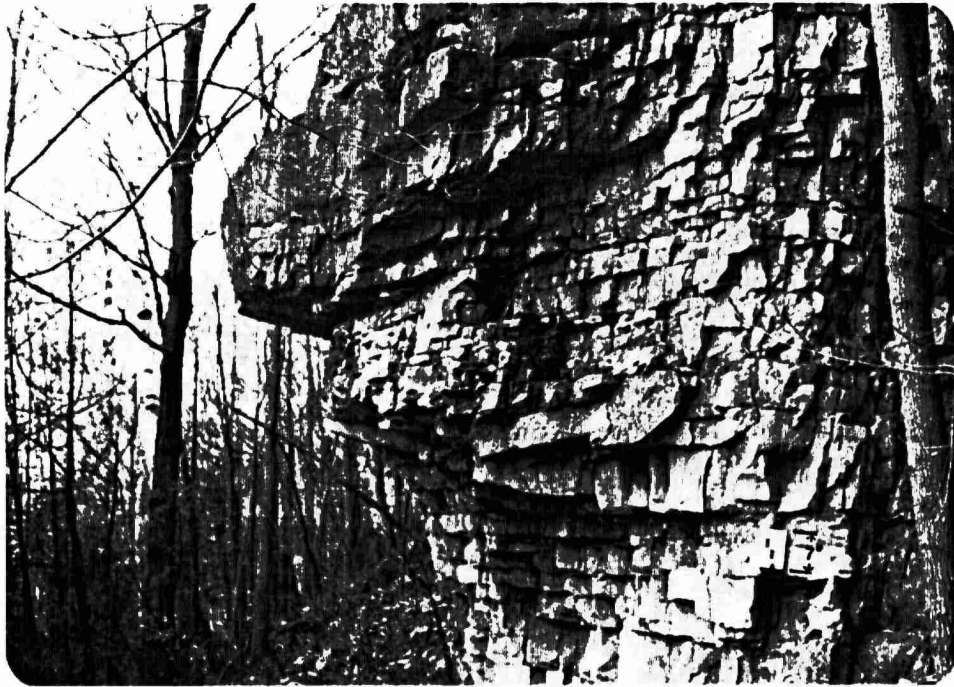


Plate 1. Massive and horizontally bedded, fractured dolomite of the Amabel and Fossil Hill Formations is well exposed on the Niagara Escarpment.

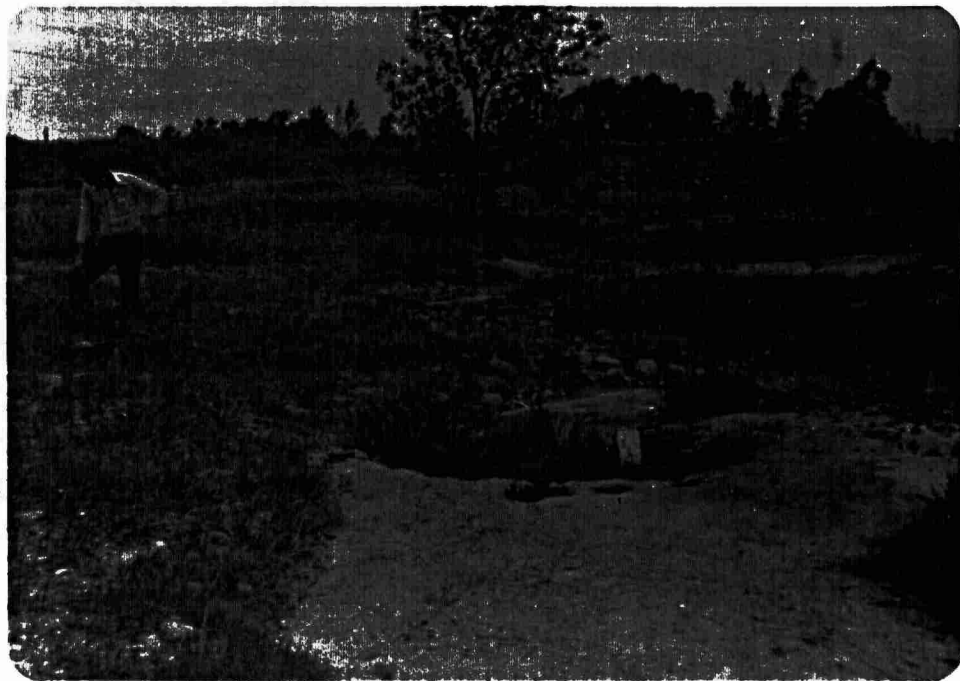


Plate 2. Small sinkholes are termination points for "short lived" streams on the top of the escarpment. The photo shows the west portion of the Wiarton Airport property. Colpoys Bay is in the background.

### Surficial Deposits

The overburden is very thin and in many areas it is absent, particularly in the central and west-central portions of the study area. Near the Boulter and the Armstrong springs, the soil is very shallow with much bare rock exposed (Plates 3 and 4). In the eastern portion of the study area, a considerable increase in overburden thickness is reported in water well records where up to 6 m of stoney, clayey silt till is present (Figure 2).

According to Chapman and Putnam (1966) the north-western section of the study area is overlain by lacustrine clay deposits. This is confirmed near the intersections of Elm and Taylor Streets (Figure 1) where the following lithologic profile is exposed in a 1.5 m stream channel: about 0.5 m of silty sand is underlain by about 1.0 m (exposed) of bluish lacustrine clay. Farther west towards Highway 6 on the north side of Elm Street and west of the CNR tracks, silty sand and gravel has been extracted in minor quantities. A similar situation exists on the south side of the access road to the Wiarton sewage lagoon. These granular materials are probably remnants of beach deposits created by a former glacial lake. At the northern margin of the Wiarton sewage lagoon, erosion by intermittent runoff has exposed a mixture of silty sand and gravel (0 to 0.2 m) which is underlain by brownish silty clay. Two test holes augered north of the lagoon revealed a 2.0 m thickness of clay. No water was reported in the holes at the time of augering (Figure 1, Appendix B).

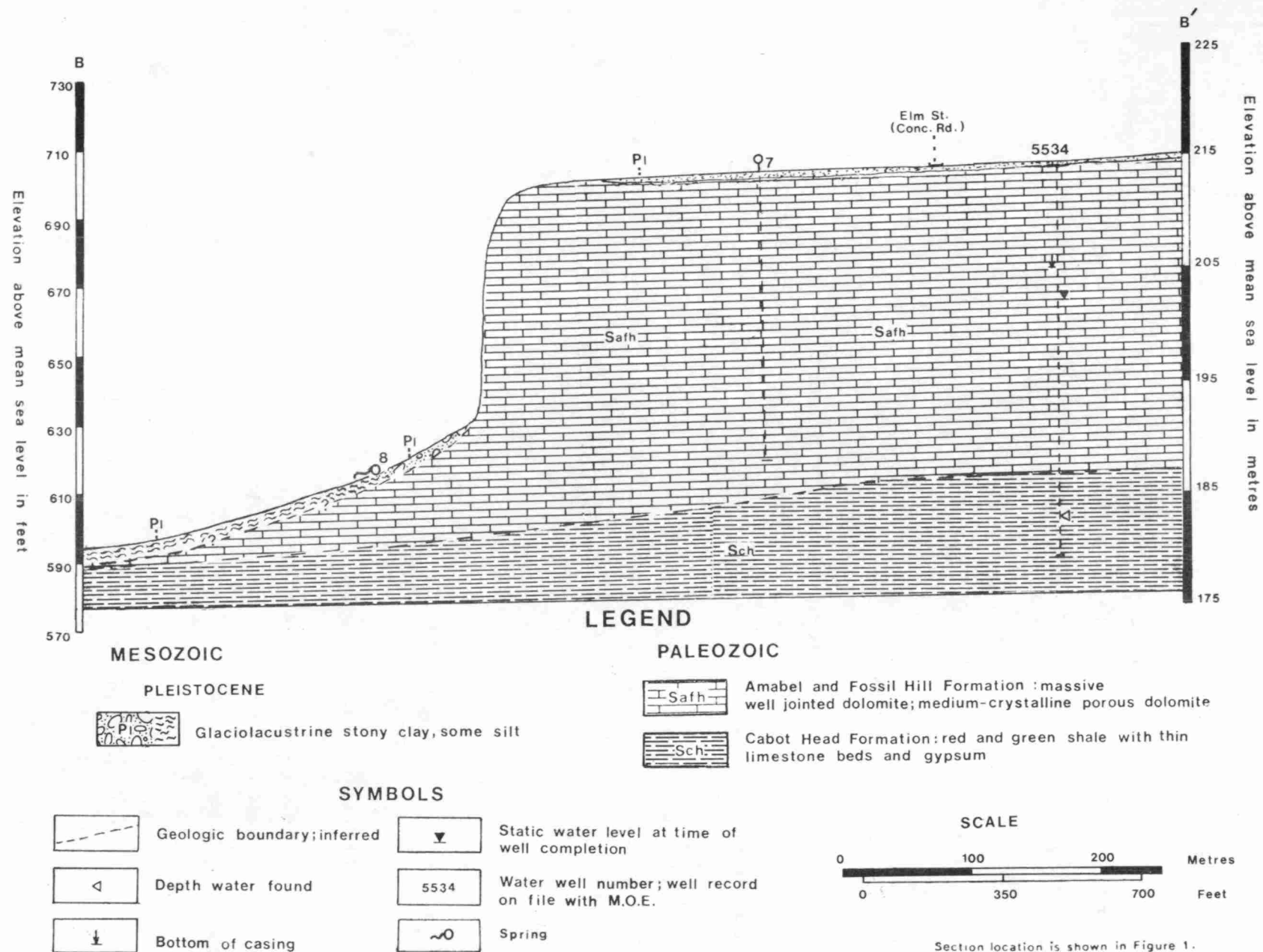


FIGURE 3. VERTICAL CROSS - SECTION B-B' SHOWING GEOLOGY AND HYDROGEOLOGY OF THE STUDY AREA.

### Groundwater Movement in Shallow Bedrock

Several domestic water supplies in the area are obtained from shallow wells or from captured springs which originate from the shallow bedrock. In addition, several springs emanate from the fractured dolomite at the toe of the escarpment. It is therefore reasoned that fissures and fractures in the Amabel and Fossil Hill dolomite constitute a shallow aquifer.

The movement of groundwater in fissured and fractured dolomite is greatly influenced by the orientation of the fracture patterns. Although no systematic measurements of these patterns was carried out, observations indicate that the chief direction of the main fractures is NW to SE. The direction of the surface water drainage pattern is similar. These factors were considered together with field observations in determining the direction of groundwater movement in this water-bearing zone (Figure 4).

### The Spring Water Supplies

#### The Armstrong Springs

The general layout of Mrs. Armstrong's water supply system and a vertical cross-section through her water supply sources are shown in Figure 5. A spring originating from the shallow dolomite bedrock is the source of water. At this locality, the bedrock is overlain by a few feet of overburden which consists of silt and silty and clayey sand.

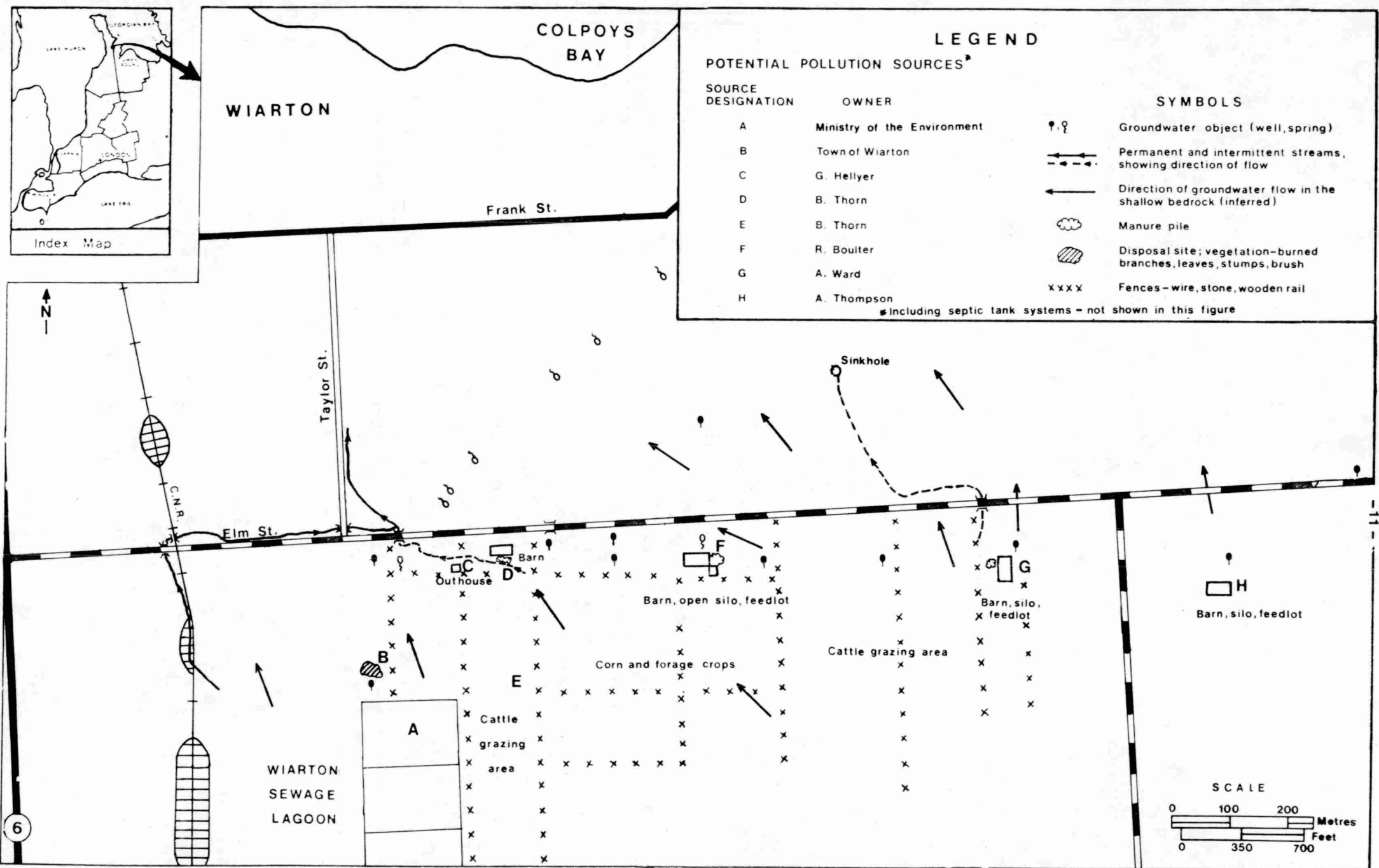


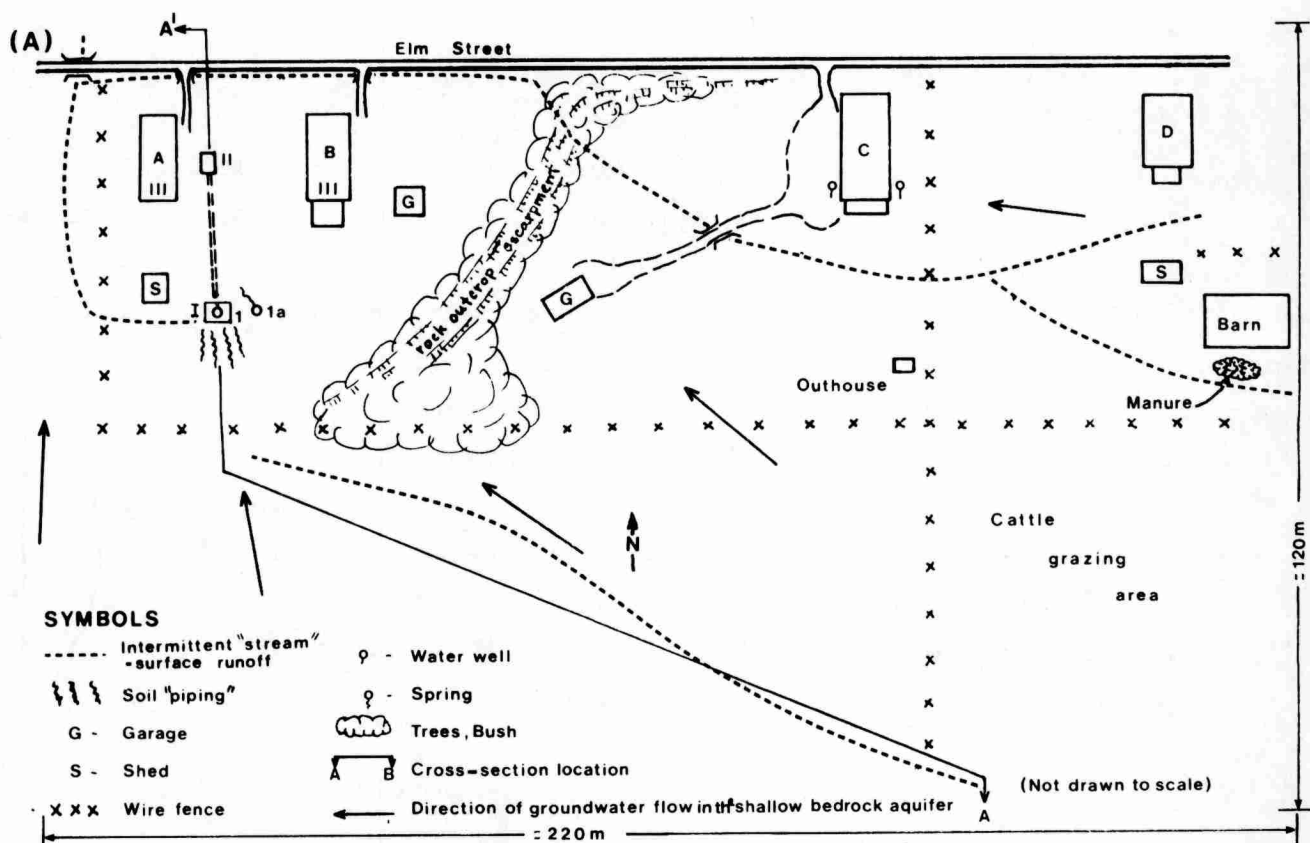
FIGURE 4. POTENTIAL POLLUTION SOURCES AND GROUNDWATER FLOW DIRECTION IN SHALLOW BEDROCK.

About 3 m east of this developed spring is an "open rock" spring which rises from a larger fracture system in the dolomite which in this location is overlain by only 0.3 m of top soil (Plate 3). Both springs were extensively sampled during the course of this investigation.

The very thin overburden at both springs makes them susceptible to pollution originating at the surface. Polluted surface water runoff can readily infiltrate into the fractured rock through the thin overburden and have an adverse effect on the water quality of the springs.

#### The Boulter Spring

The Boulter spring which is used for stock watering does not discharge at ground level. It has been "developed" in an elongated excavation up to 2 m in depth which intercepts groundwater that flows through fractures in the rock. A barrier has been placed in the excavation to create a pumping reservoir and water can be heard cascading over this barrier. At this locality the horizontally bedded dolomite is overlain by a thin veneer of soil, and several outcrops are present in the immediate vicinity of this spring. A fenced feedlot is located about 65 m south-southwest of this spring. The main feedlot and an open silo adjacent to it are located 90 m from the spring, immediately beyond the barn (Plate 4).



KEY

A - The Armstrong residence

B - The Baker residence

C - The Hellyer residence

D - The Thorne residence

Sampling points of Mrs. G. Armstrong's (V. Baker) domestic water supply.

I, 1 - Captured spring (1a open spring)

II - Settling tank

III - Kitchen tap

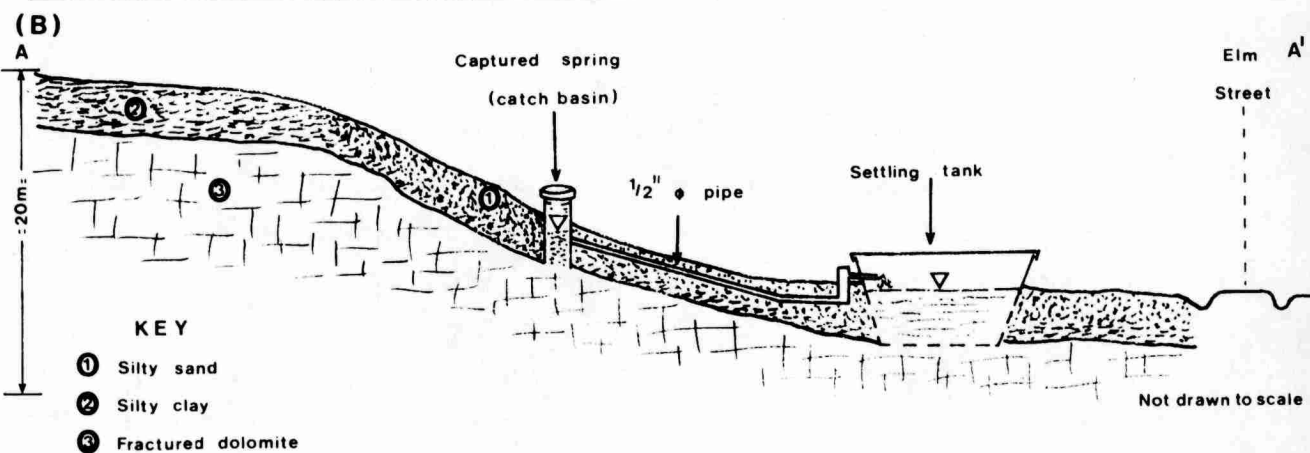


FIGURE 5. SKETCH SHOWING GENERAL LAYOUT OF MRS. G. ARMSTRONG'S WATER SUPPLY SYSTEM (A) AND VERTICAL CROSS-SECTION THROUGH THIS WATER SUPPLY SYSTEM (B).

## POTENTIAL POLLUTION SOURCES

Figure 4 locates potential sources of pollution. Cattle grazing areas constitute diffuse sources of pollution, while the remainder are considered point sources. Point sources located in areas where the overburden is very thin or absent (locations designated as C, D and F in Figure 4) are considered greater threats to groundwater quality than are the other sources. Where the overburden is thin or absent, there is little attenuation of pollutants because the travel paths of pollutants are relatively short before reaching the fractured rock and the groundwater. Furthermore, ionic exchange, fixation and other attenuating processes are negligible in fractured rock.

Although not identified as potential pollution sources in Figure 4 it should be kept in mind that the septic tank systems used by every household are in fact point sources of pollution. The main potential pollution sources are described in the following sections.

### Wiarton Sewage Lagoon

The Wiarton sewage lagoon was completed in August, 1959 as a provincial project by the former Ontario Water Resources Commission. The lagoon is currently owned and operated by the Ministry of the Environment.

Various minor projects pertaining to the upgrading and the operation of the sewage system have resulted in some additional construction, but the three cells have remained undisturbed since completion. The lagoon effluent is discharged twice annually to Colpoys Bay (Figure 1).



Plate 3. Looking southeast; the Armstrong springs occur below a gentle undulation on the escarpment slope. The edge of tree cover marks the line of outcropping bedrock.



Plate 4. Looking southwest; the Boulter spring is in the foreground (shed) surrounded by several rock outcrops. The main feedlot is beyond the barn, while a smaller feedlot is on the left side of the barn.

No information is available concerning geotechnical conditions at the lagoon site; however, topography at the site and available information indicate that the southern half of the lagoon was excavated to a depth of approximately 2 m, whereas the northern half was raised as much as 3 m. It is assumed that the excavated material removed from the southern section was utilized to raise the northern portion of the lagoon. As a result, the bottom of the greater part of the northern cell is above original ground surface.

The exact thickness of overburden material at the lagoon site is not known; however, the test holes bored in connection with this investigation indicate that the glacio-lacustrine clay deposit is more than 2 m thick.

No signs of leakage from the lagoon were visible at the lagoon berms. Past observation and research has shown that the chances of seepage from sewage lagoons decreases with time. This is largely due to a natural self-sealing of the bottom and the sides with sedimentation of the suspended solids. Therefore any leakage from a sewage lagoon would most likely occur soon after completion.

#### Feedlot Operation and Cattle Grazing Area

No significant runoff was observed to be leaving the Boulter feedlot (Plates 4 and 5) except on the northern side where a small amount moved a distance of about 20 m from the feedlot, before infiltrating into the ground. The reason for this is that this feedlot is unpaved and most of the liquid generated readily infiltrates into the ground.

In contrast to the situation at spring 2 where there are several outcrops, the test hole H3 located at the edge of a smaller feedlot operated by Mr. Boulter (about 60 m distance from spring 2) indicated at least 1.3 m thick overburden consisting of silty clay till. During 1977 the number of cattle kept at this site was substantially reduced and only 25 head were maintained here.

The Ward feedlot (Plate 6) is concrete-paved and also fenced with concrete. The runoff leaves the feedlot area at the northwestern corner forming a small pond just outside the feedlot fence. From here, it moves in westerly and northerly directions. On one occasion, runoff was observed to move about 80 m due west where it infiltrated into the ground just before reaching the first fence (Figure 4). Moving in a northerly direction, the runoff gains direct access into the intermittent stream which flows across the Wiarton airport field and terminates in several small sinkholes (Figure 4, Plate 2).

The cattle grazing areas are considered diffuse potential pollution sources. The problem here is similar to that discussed above in that rainfall and surface water runoff dissolve and mobilize chemical components in the manure. A good portion of this water eventually infiltrates through the relatively thin overburden and reaches the shallow fractured bedrock before it is totally renovated. Other portions of surface water runoff eventually end up in Georgian Bay.

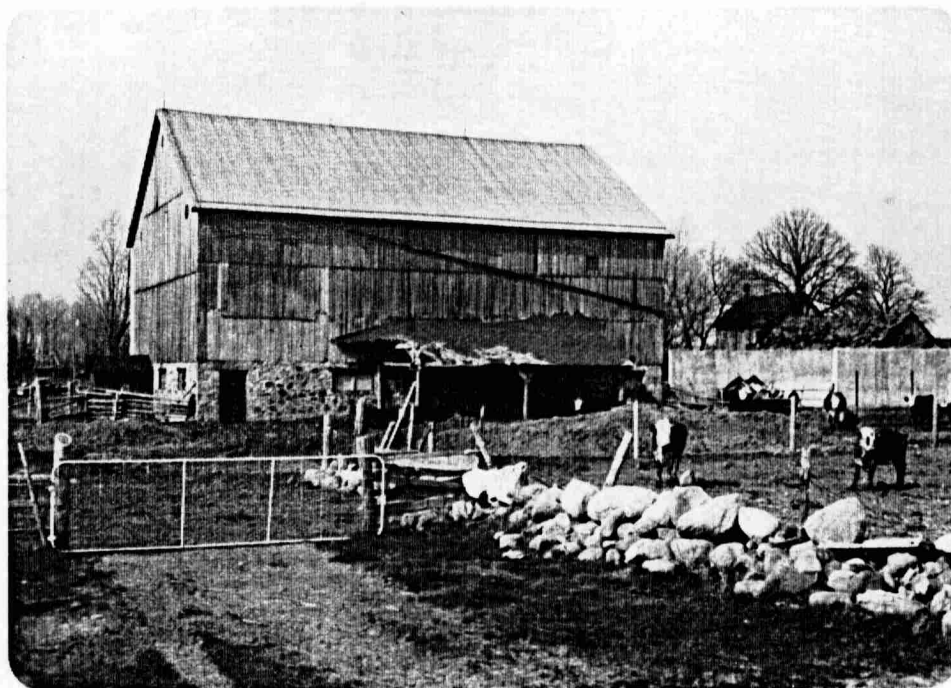


Plate 5. A typical unpaved feedlot operation. Looking northwest; the Boulter feedlot, barn, and open silo (at the right margin). The Boulter spring is behind the barn building.

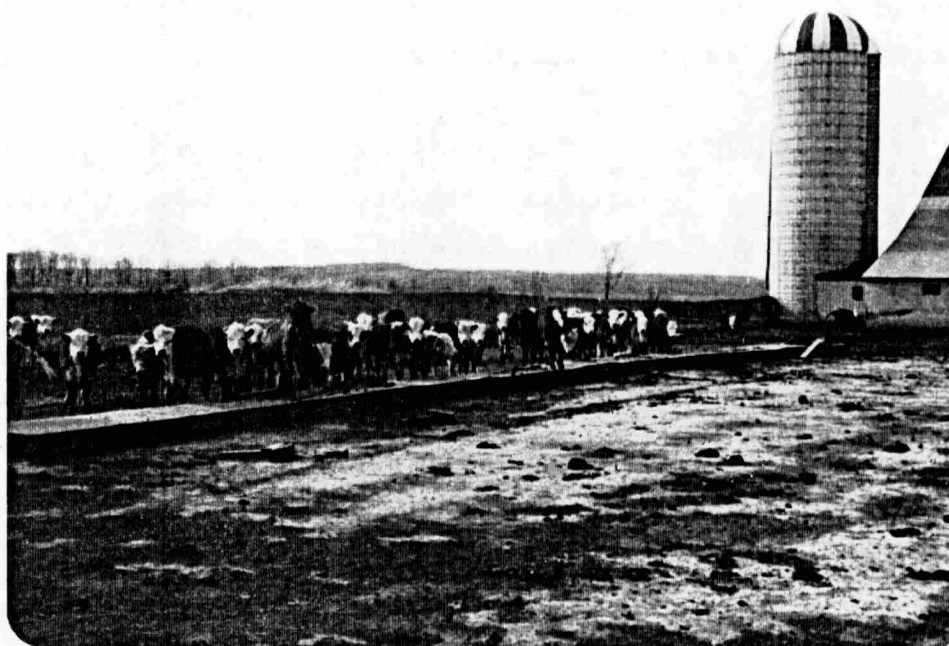


Plate 6. The Ward feedlot is paved and concrete-fenced. Looking northwest; the Niagara Escarpment (across Colpoys Bay) is in the distant background.

### Other Potential Pollution Sources

Septic tank effluents (associated with each household in the study area) are considered to be potential pollution sources to shallow groundwater in the area. This is particularly true for the area where the overburden is very thin such as at potential pollution source C in Figure 4. At this location domestic wastes are reportedly dumped into a "reservoir" dug into the bedrock.

Potential pollution source D is located in an area where the overburden is very thin and where a manure pile is situated several meters from the intermittent stream (Plate 7). The number of cattle (young calves) at this locality numbered up to 20 in 1977.

Where the overburden thickness exceeds 3 m such as near potential pollution source H, the danger that the pollution source may affect groundwater quality is greatly reduced. In any case, the feedlot fence is only 3 to 5 m from the well and greater separation distance is desirable. During 1977 this feedlot was not in operation.

### WATER QUALITY

In order to establish groundwater quality changes in the area of investigation, the existing domestic wells and springs, the surface water runoff, and the suspected pollution sources were sampled on several occasions and analysed for chemical and bacteriological quality.

The initial samples were taken from Mrs. Armstrong's spring in November, 1975. The last set of samples (taken from various sources) were obtained in November, 1977.

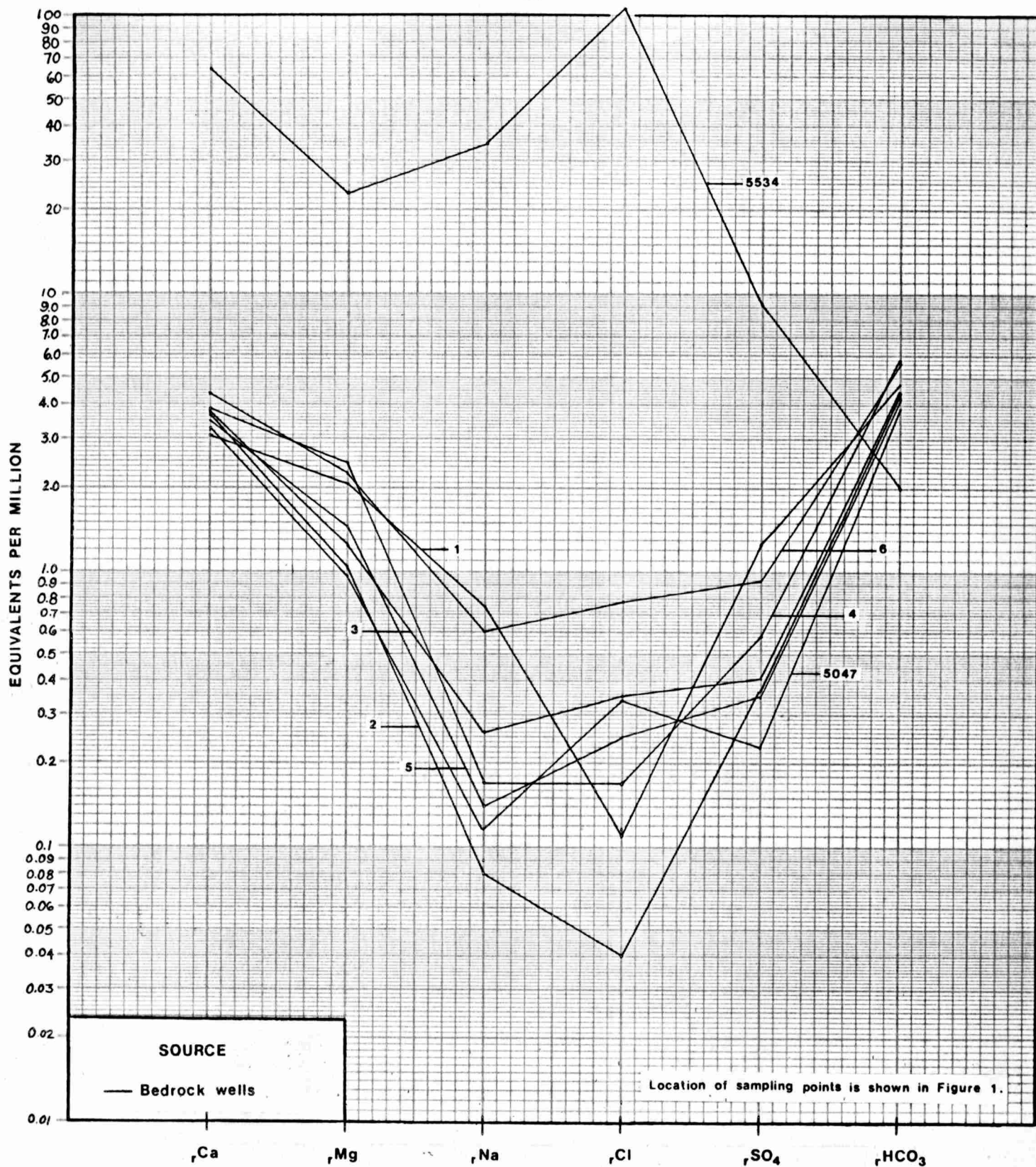
In this section, reference is made to several of the existing wells and springs as they are shown in Figure 1. The corresponding names of the well and spring owners are given in the Appendices of this report.

The summaries of chemical analyses are provided in Appendices D through G inclusive, while bacteriological analyses are summarized in Appendices H through K.

### Chemical Quality

The chemical analyses of the sampled sources are presented in three modes: (i) the complete chemical analyses (those which include major cations and anions) are plotted on semi-logarithmic diagrams (Figures 6 to 8), as described by Schoeller (1937), (ii) several chemical constituents (for 6 sampling dates) are plotted in chronological order of sampling on hydrochemical maps (Figures 10 to 14 in Appendix C), and (iii) the complete chemical analyses are plotted on the triangular diagram (Piper, 1946) in Figure 15, Appendix C).

In the following paragraphs a brief discussion of water quality in both the deeper bedrock and the shallow dolomite bedrock aquifer is provided.



DATE SAMPLED: March 8, 1977

FIGURE 6. SEMI-LOGARITHMIC DIAGRAM OF CHEMICAL ANALYSES OF WATER FROM THE BEDROCK AQUIFER.

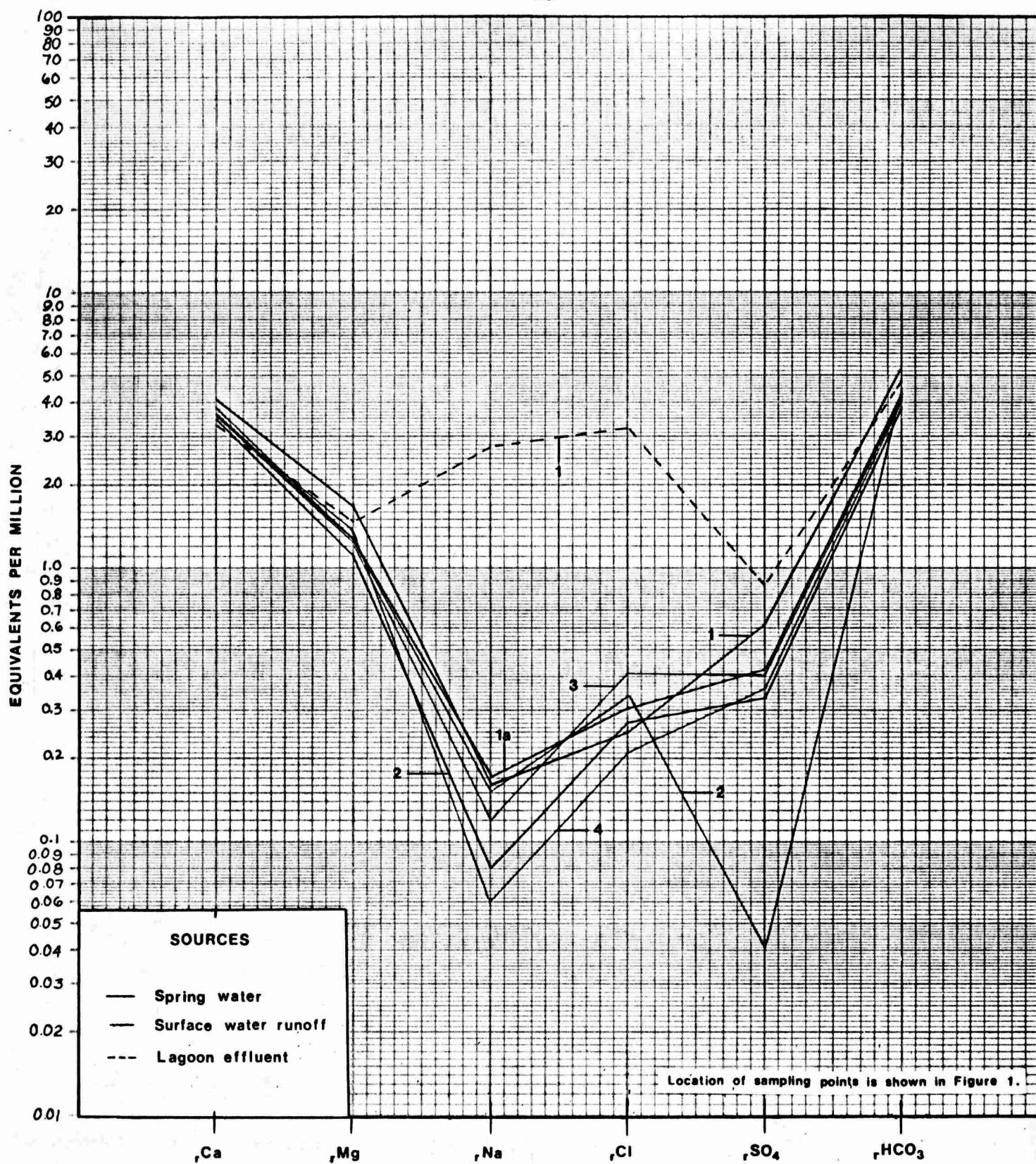
### Deeper Bedrock Wells

Wells which were completed in the shales of the Cabot Head Formation are included in this group. There are records for five such wells. Two were abandoned because of poor water quality, but three are still used for domestic purposes namely; 3720, 4528 and 5534. Well 5534 was more frequently sample than the other two.

In general, the chemical quality of wells completed in the shale is characterized by elevated concentrations of chloride, sulphate, sodium and potassium. In well 5534 the total dissolved solids concentration is approximately 10,000 milligrams per litre (Appendix D). In addition, elevated levels of free ammonia, total kjeldahl nitrogen, (Figure 10 in Appendix C) chemical oxygen demand and iron (Appendix D) indicate ongoing pollution in this well. Three potential pollution sources in the immediate vicinity of this well are the cattle feedlot, the cattle grazing area, and a septic tank system (Figure 4). Poor well completion (Plate 8) may be a contributing factor to the increased levels of organic compounds in this well.

### Shallow Bedrock Aquifer

The Amabel and Fossil Hill Formations (and the groundwaters they contain) are considered to constitute the shallow bedrock aquifer (Figures 2 and 3). Several springs which occur at the base of the escarpment (Figures 1 and 3) discharge from this carbonate aquifer system. Additionally, there are also several drilled wells completed into this shallow fractured rock aquifer (wells 1, 2, 3, 4, 5047).



DATE SAMPLED: March 8, 1977

FIGURE 7. SEMI-LOGARITHMIC DIAGRAM OF CHEMICAL ANALYSES OF SPRING AND STREAM WATERS AND OF LAGOON EFFLUENT.

Two springs (designated as spring 1 and spring 2; Figure 1) were the most extensively sampled in the course of this investigation. Spring 1 (Plates 3 and 12) which is owned by Mrs. G. Armstrong is used as a source of domestic supply, whereas, spring 2 (Plates 4 and 9) is used for stock watering purposes.

Actually, there are two springs on Mrs. Armstrong's property; the captured spring (designated as 1) and an "open rock" spring designated as spring 1a (Figure 1, and Plates 3 and 12). Although these two springs are located about 3 m apart, they show significant differences in water quality (Figures 10 to 15 and Appendix D). Greater variations, both in water quality and quantity were exhibited by spring 1a indicating that it is more strongly influenced by surface runoff which is contaminated by organic pollutants and phenols (Figure 13 in Appendix C). Spring 1 flows year-round at an extremely low rate whereas spring 1a dries up during the summer period. It is concluded that these two springs are associated with two separate fracture systems in the carbonate rock.

In general, similar chemical trends are exhibited by the springs, shallow wells and the surface water runoff. Indeed, all three analyses (Figures 6 to 8) indicate the influence the feedlot runoff is having on the quality of surface water runoff and on the shallow groundwaters.

Another characteristic of water quality contamination in the shallow aquifer is the very low sodium to potassium ratio (Figure 14). This ratio may be used (knowing the general background ratio) as an indicator of pollution.

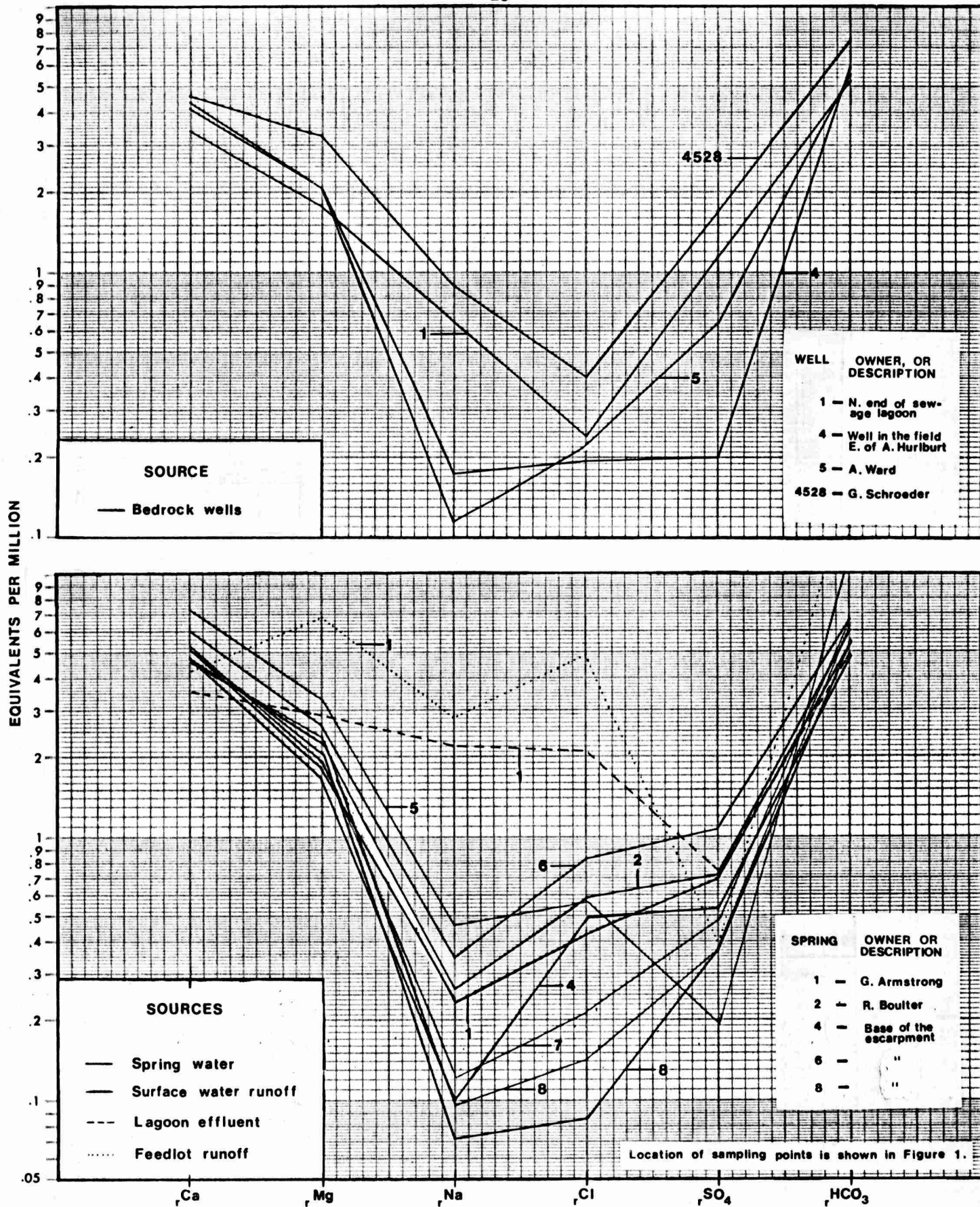


FIGURE 8. SEMI-LOGARITHMIC DIAGRAM OF CHEMICAL ANALYSES  
WITHIN THE STUDY AREA.

No significant changes in chemical quality occurred in this aquifer between two sampling dates (March 8, 1977 and November, 1977) as indicated by Figures 6 to 8.

#### Bacteriological Quality

A summary of bacteriological analyses from groundwater and surface water sources obtained during the course of this investigation is given in Appendices H and I. Tables 1 to 3 give the bacterial concentrations in the sampled water sources on three selected sampling dates.

The presence of fecal coliforms (FC) and fecal streptococci (FS) indicates recent contamination from human or animal excrement. An attempt was made to use the qualitative relationship between these indicator organisms to indicate a probable source of pollution.

Table 1. Concentrations of Indicator Bacteria in the Sampled Sources, November 29, 1976.

Source*	Fecal Coliform (FC)	Total Coliform	Fecal Streptococci (FS)	Ratio FC:FS
(Number of bacterial colonies per 100 ml)				
Q3720	L2	L2	L2	
Q4528	L2	L2	L2	
Q5534	L2	L2	L2	
Q1a	26	3,200	30	0.87
Q1	L2	L2	L2	
Q2	L2	8	L2	
Q4	L4	23,000	68	
Q5	66	118,000	78	0.85
Q6	36	7,700	106	0.34
Q7	4	148	10	0.4
Q2	660	146,000	1,800	0.37
Δ2	36	194	80	0.45
Δ3	276	23,000	208	1.33

- \* Q Bedrock well  
 Q Bedrock spring  
 Δ Stream-surface runoff  
 L-Refers to less than

According to Geldreich and Kenner (1969), the FC:FS ratio may be used to identify a probable source of pollution. They reported that FC:FS ratios were always greater than 4.0 in human feces and in domestic wastewaters, while they were less than 0.7 in the feces of farm animals, cats, dogs, and rodents and in wastewaters polluted with these feces.

In Figure 9, the FC concentrations are plotted against the FS concentrations for each sample (for four sampling dates) in which bacterial colonies were detected. These included five different sources totalling 23 samples. Of the 23 samples, only four had FC:FS ratios greater than 4.0 suggesting a human source. Twelve had FC:FS ratios which were less than 0.7 suggesting animal sources. This technique is subject to numerous variables and is used here in an effort to gain a general understanding of the problem. However, it should be noted that the sewage lagoon effluent and feedlot runoff do fall into the  $>4.0$  and  $<0.7$  categories respectively as this methodology suggests they should.

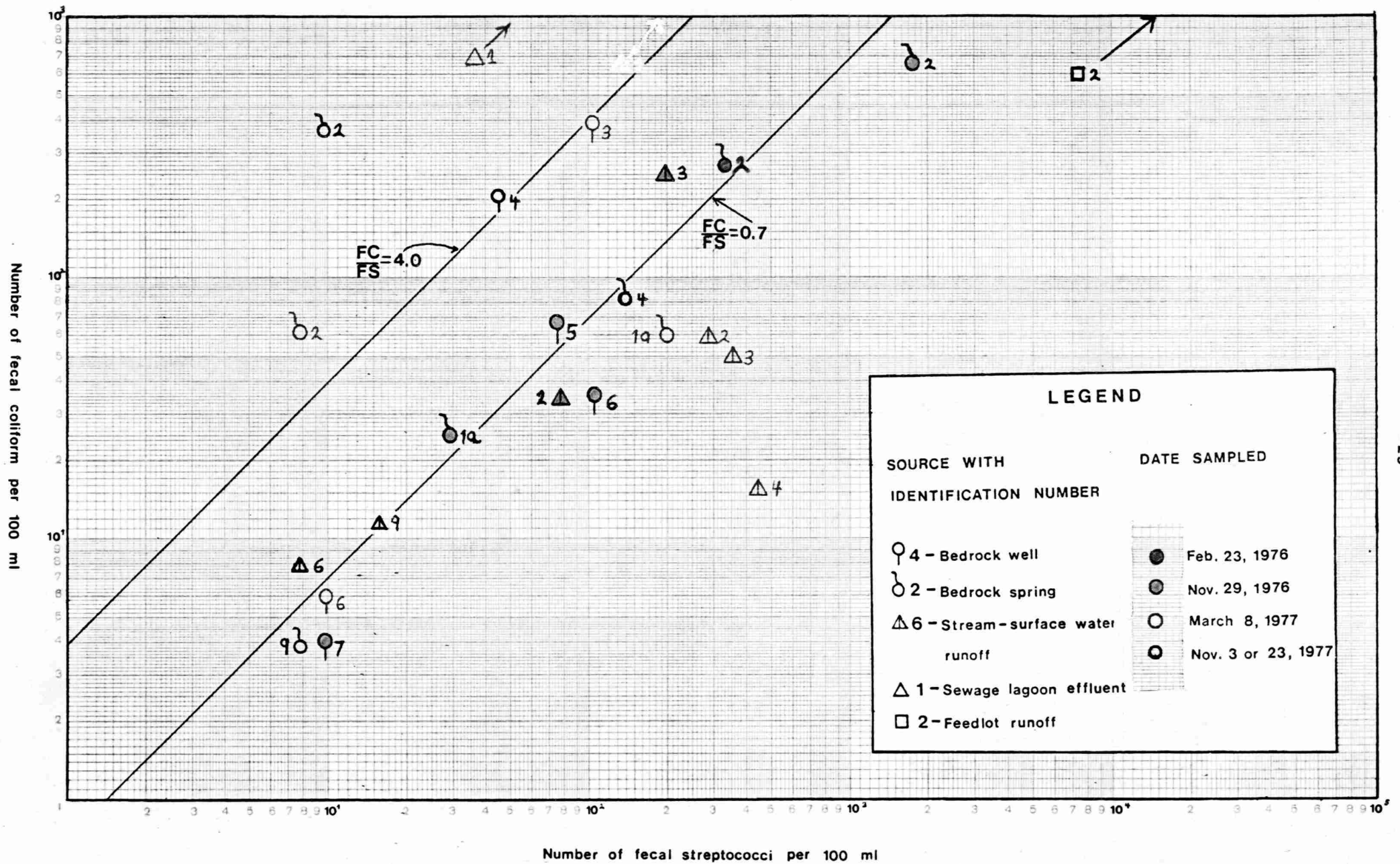


FIGURE 9. FECAL COLIFORM CONCENTRATIONS COMPARED TO FECAL STREPTOCOCCI CONCENTRATIONS IN SAMPLED SOURCES IN THE STUDY AREA.

Table 2. Concentrations of Indicator Bacteria in the Sampled Sources, March 8, 1977.

Source*	Fecal Coliform (FC)	Total Coliform	Fecal Streptococci (FS)	Ratio FC:FS
(Number of bacterial colonies per 100 ml)				
○ 5047	L2	6	0	
○ 5534	L2	L2	0	
○ 1a	60	900	202	0.30
○ 1	L2	L2	L2	
○ 2	L2	L2	L2	
○ 3	400	16,200	108	3.7
○ 4	L2	L2	200	
○ 5	2	6	2	
○ 6	6	10	10	0.6
○ 1	L2	L2	L2	
○ 2	64	6,500	8	8.0
△ 2	60	1,200	296	0.20
△ 3	52	2,100	368	0.14
△ 4	16	1,400	456	0.04
△ 1	422,000	980,000	19,100	22.0

- \* ○ Bedrock well  
 ○ Bedrock spring  
 △ Stream-surface runoff  
 △ Sewage lagoon effluent  
 L-Refers to less than

Some of the difficulties in utilizing bacterial quality to identify pollution sources are the apparent seasonal variations and the frequent absence of fecal coliform bacteria in the analysed samples (Tables 1, 2 and 3 and Appendix H). The best example of the influence of seasonal changes on the source of pollution is the Boulter spring (spring 2). Of six available FC:FS ratios, two were less than 0.7 whereas two were greater than 4.0 and the remaining two had ratios between 0.7 and 4.0. Thus, using the criteria, as suggested by Geldreich and Kenner (1969), both human and animal wastes contribute to the bacteriological quality deterioration. This might be the case, since both potential pollution sources (septic system and feedlot) are located within 60 m of the spring and both sources are situated in the same hydrogeological environment.

Bacteriological analyses confirmed that spring 1 and spring 1a (the Armstrong springs) are not hydraulically connected. Six bacteriological analyses from spring 1 were fecal coliform free, and one had very low bacterial counts. In contrast, three bacteriological analyses from spring 1a (taken at the same date as those from spring 1) showed high fecal coliform counts. In this respect, bacteriological analyses from these two springs are in good agreement with the results of the chemical analyses.

Table 3. Concentrations of Indicator Bacteria in the Sampled Sources, November 3, or 23, 1977.

Source*	Fecal Coliform (FC)	Total Coliform	Fecal Streptococci (FS)	Ratio FC:FS
(Number of bacterial colonies per 100 ml)				
○ 4528	L2	L2	L2	
○ 5534	L2	L4	L2	
○ 1	L4	L4	L4	
○ 4	210	1,800	46	4.56
○ 5	L2	140	6	
○ 1	L2	156	L2	
○ 2	370	14,000	10	37
○ 4	84	700	140	0.6
○ 6	L2	24	L2	
○ 8	L2	178	46	
○ 9	4	112	8	0.5
△ 5	L4	1,600	1,444	
△ 6	8	160	8	1
△ 9	12	100	16	0.75
△ 10	24	140	8	3
□ 2	130,000	40,000,000	11,000,000	0.01

- \* ○ Bedrock well  
 ○ Bedrock spring  
 △ Stream-surface runoff  
 □ Feedlot runoff  
 L-Refers to less than

## DISCUSSION

### Vulnerability to Pollution of the Armstrong Springs

Hydrogeology and groundwater chemistry are the two main factors used here to identify sources of groundwater pollution. Semi-logarithmic diagrams of chemical analyses from four different sources indicate that the chemical quality of the lagoon effluent is entirely different from the chemical quality of the local ground and surface waters (Figures 7 and 8). This, and several other factors preclude the likelihood that the Warton sewage lagoon is leaking and polluting Mrs. Armstrong's water supply.

Other factors are:

1. Several feet of lacustrine clay separate the bottom of the lagoon from the bedrock.
2. No apparent leaks at the lagoon base or at the lagoon berms were observed.
3. A shallow bedrock well located near the lagoon (well 1 in Figure 1) which should have been affected first if the lagoon were leaking showed no signs of water quality deterioration.
4. The concentrations of phenols during the winter months were relatively high in the lagoon effluent; yet, in the Armstrong spring, concentrations were less than 1 part per billion (Figure 12 in Appendix C).

5. The sodium to potassium ratio (Na/K) was relatively high in the lagoon effluent, but in the Armstrong spring it was extremely low, approaching the value typical of surface water (Figure 14). This suggests that the pollutants entering the shallow aquifer system are associated with surface water runoff.

It is apparent that phenols and nutrients reach their highest concentration levels in the Armstrong springs during late autumn. At this time there is an abundance of manure on the ground particularly in the cattle grazing area (potential pollution source E in Figure 4). In the early spring of 1977 after a rapid snow melt it was observed that surface water runoff originating in the area of potential pollution source E flowed towards the Armstrong spring along very shallow undulations on the ground surface (Figure 5).

Approximately 50 m before it reached the Armstrong spring, the runoff infiltrated into the ground and reappeared around both the captured and "open rock" springs. From here, it moved along the ground surface. While moving along the interface between the bedrock and overburden it caused soil "piping" in the immediate vicinity of both springs (Plate 12). This observation confirms earlier suggestions that the surface water may indirectly transport pollutants from area E to the shallow bedrock from which water in both springs originates.

The contributions to the deterioration of water quality in the Armstrong springs from the two other nearby potential pollution sources (C and D in Figure 4, Plate 7) are difficult to assess accurately at this time. However,

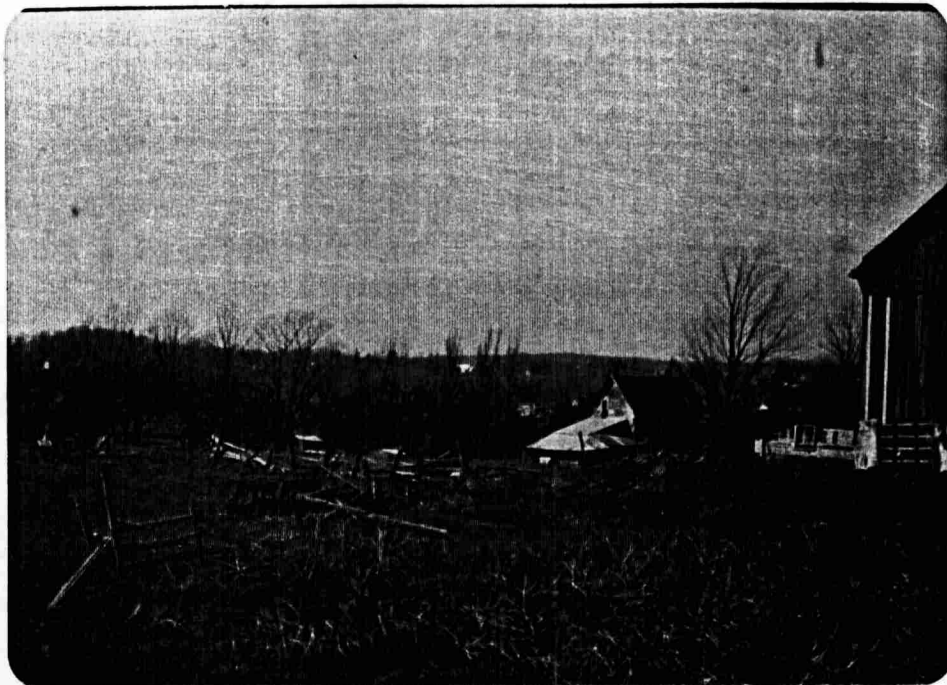


Plate 7. Looking northwest; the manure pile is located immediately beside the intermittent stream. The outhouse is slightly left of centre (shed) while the Armstrong springs are beyond the building on the left.

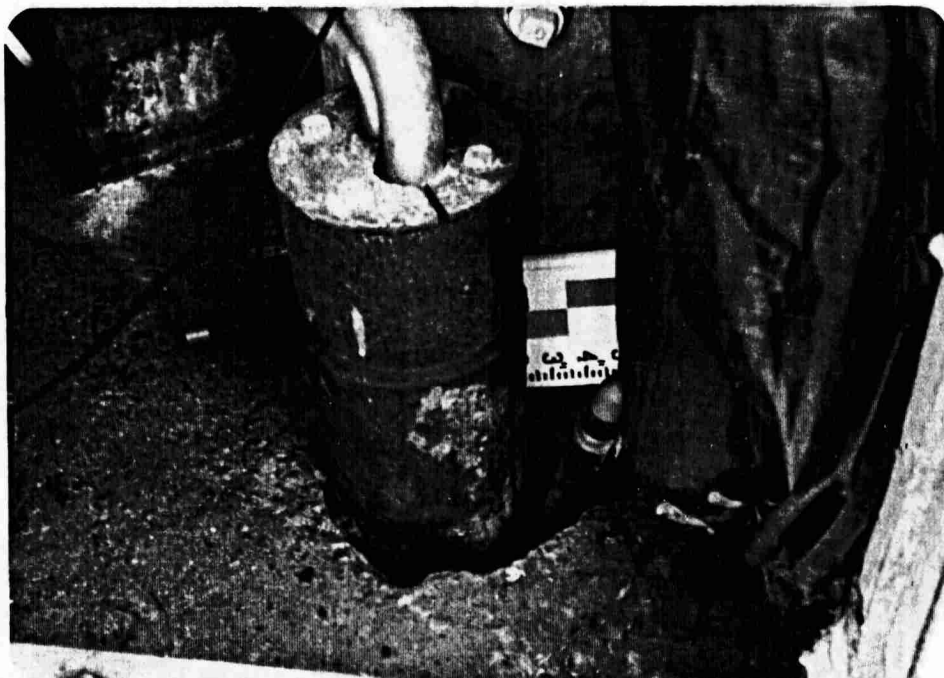


Plate 8. Although housed in the small pumphouse and protected from frost, the well serving the Hurlburt family (well 5534) is unsatisfactorily completed. The annular space between the drill hole and well casing has been left ungrouted.

it is unlikely that these sources are a significant cause of water quality deterioration in the Armstrong spring 1.

#### The Boulter Spring

By hydrogeological definition this is not a spring; it is rather a shallow "trench" up to 2.2 m deep, 0.4 to 1.0 m wide and 3.0 to 5.0 m long. It has been excavated into horizontally bedded dolomite (Plate 9) and water from it is used for stock watering purposes. This spring (spring 2 in Figure 1) is located at about 60 m from the feedlot.

It is unlikely that the cause of water quality deterioration in the Boulter spring is source G (Figure 4) because:

1. Groundwater movement in the shallow bedrock in these localities is in a north-northwesterly direction and the Boulter spring is located west of potential pollution source G (Figure 4).
2. The concentrations of phenols in the Boulter spring were significantly higher (November, 1976) than in the shallow well (well 4 in Figure 1) located about half way between potential pollution source G and spring 2 (Figure 13). Other chemical parameters such as nutrients and coliform bacteria behaved similarly.
3. Potential pollution source F (Figure 4; Plate 5) located about 60 m away from the Boulter spring shows high concentrations of phenols, nutrients and other chemical constituents. A correlation has been established between this source and increased concentrations of a number of chemical parameters in the Boulter spring.

It is therefore concluded that the likely source of the Boulter spring pollution is source F as indicated in Figure 4. Bacteriological analyses suggest that the effluent from the adjacent septic tank disposal system serving the Hurlburt family might also contribute to water quality deterioration in this spring.

The relatively high concentrations of sodium, chloride, potassium, and sulphate in the well water used by the Hurlburt family (well 5534) are due to the natural presence of these parameters in groundwaters in the Cabot Head Formation. However, increased concentrations of nutrients in this well water may originate at nearby source F, or from the cattle grazing area located immediately east-southeast of the well. Faulty well construction (Plate 8) provides direct access of pollutants to the well bore.

#### Other Complaints of Groundwater Supply Pollution

The domestic well used by the Symon family (well 5 in Figure 1) has experienced only slight chemical contamination; however, bacteriological quality indicated the water to be unacceptable for human consumption during the sampling program. Pollution source G (Figure 4) located in the immediate vicinity of this well is the probable cause of the poor bacteriological quality.

Well 6 (Figure 1) is used by the Brown family. It is considered that increased nutrient concentrations in this well were caused by pollutants originating from the nearby

feedlot (source H in Figure 4). The water sample taken from this well in May, 1977 was bacteria-free and at this time the feedlot was not operated.

Water well 5047 belongs to the Keith family. This well experienced slightly elevated nutrient concentrations that probably originated from their own septic tank system.

The impact on water quality in domestic wells 5 and 6 is due mainly to the feedlot operation since the potential for contamination from septic tank effluents is greatly reduced by the relatively thick, poorly permeable overburden. However, the surficial deposits do not provide complete renovation and a small amount of contamination does reach these domestic wells.

#### RECOMMENDATIONS

Earlier discussion has indicated that the carbonate aquifer is located in a sensitive hydrogeological environment and that it is very vulnerable to pollutants originating at or near ground surface. In particular, the shallow water bearing zone utilized by Armstrong and Boulter (by means of captured springs) is quite susceptible to contamination.

We understand that the residences of Mrs. Armstrong and her neighbour G. Urbshott (who used well 2 in Figure 1) were recently connected to the Town of Wiarton watermain. However, Miss Baker is still using spring water (spring 1) which she had shared with Mrs. Armstrong.

The implementation of either of the two following recommendations would replace the Armstrong spring:

1. Connection of Miss Baker's residence to the Town of Wiarton water supply system (up to 50 m distance from Mrs. Armstrong's residence).
2. Drilling a new deeper well into dolomite of the Amabel and Fossil Hill Formations. A new well should not be deeper than 20 m to avoid obtaining mineralized water from shales of the Cabot Head Formation. A new well should be properly constructed with the well casing placed as deep as practical, and cement grout placed in the annular space between the drill hole and well casing. An experienced water well contractor should be employed for this work.

Since Miss Baker is still using spring 1 (the Armstrong spring) the following measures are recommended to minimize impact on spring water quality and on water quality in the local area:

1. The cattle grazing area (source E in Figure 4) should be restricted to the area south of the northern edge of the Wiarton sewage lagoon.
2. Runoff in the vicinity of Mrs. G. Armstrong's springs should be controlled. This could be accomplished by the establishment of shallow interception ditches located at two localities: (i) a north-south ditch along the west boundary of the Thorn property but north of the sewage lagoon and, (ii) an east-west ditch parallel to the southern boundary of Mrs. Armstrong's

property (backyard). The interception ditches would divert any surface water runoff from getting close to the Armstrong springs.

3. The manure piles at pollution source D (Figure 4, Plate 7) should be removed taking appropriate measures to prevent pollutants associated with this operation from infiltrating into the fractured bedrock and from entering the nearby intermittent stream.
4. Wastes in the outhouse (source C in Figure 4) should be isolated and prevented from entering the fractured bedrock.

With respect to the protection of water quality in the Boulter spring and groundwater in general, the quality, and quantity of feedlot runoff and the operation of feedlots require that they be controlled. The types of control measures employed must protect water quality and at the same time must be readily implementable and economically realistic. It is considered that runoff from cattle feedlots can be satisfactorily controlled and treated by retention-evaporation ponds, and that liquid waste can be confined in a holding pond to be sprayed on the land.

Since the study area has a very sensitive hydro-geologic environment the following control measures are recommended:

1. The feedlots and barnyards should be paved in order to prevent feedlot effluent from entering the groundwater system.
2. Surface water runoff should be prevented from entering feedlots and from contacting manure storage areas.

3. Retention ponds should be constructed for all waste water and for runoff which contacts animal wastes.
4. If the above measures are unsuccessful in reducing groundwater pollution, it may be necessary to reduce the number of cattle at particular feedlots in order to restore groundwater quality. Additional study concentrating on the impact of septic systems could also be undertaken if the above measures do not affect a significant improvement. Such a study should be undertaken respecting the Keith well.
5. The application of solid and liquid wastes in particular, to agricultural lands should be restricted to areas with adequate overburden. As a general guideline the overburden should be at least 1.5 m in thickness and should consist of medium to low permeable material such as silty, sandy clay, or silty clayey sand. However, in the areas where there is no potential of affecting water supply well, spring and surface water manure may be spread on land with relatively thinner overburden.

Pay  
Code  
of Practice  
Sludge handling

Modifications in feedlot design will assist in reducing the polluted runoff. The observations that moist and wet feedlots produced a more concentrated runoff indicates that feedlots should be designed to drain and to dry as rapidly as possible. Because the quantity of runoff is a function of the area involved, feedlots should be designed to be as compact as possible.

Faulty well construction at well 5534 (Figure 1, Plate 8) used by the Hurlburt family should be corrected.

#### ACKNOWLEDGEMENTS

Text of the report was critically reviewed by Ken Goff.

Several persons were involved in collecting information (water samples) in the field. Listed in the chronological order of their initial involvement they are: Larry Struthers, Philip Bye, William Currie, Tom Ervasti, Cindy Riediger and Brian Jaffray.

Drafting and assemblage of the appendices were done by Jim Owen, Cindy Riediger and Tom Ervasti.

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APPENDIX 1

ADDITIONAL PLATES

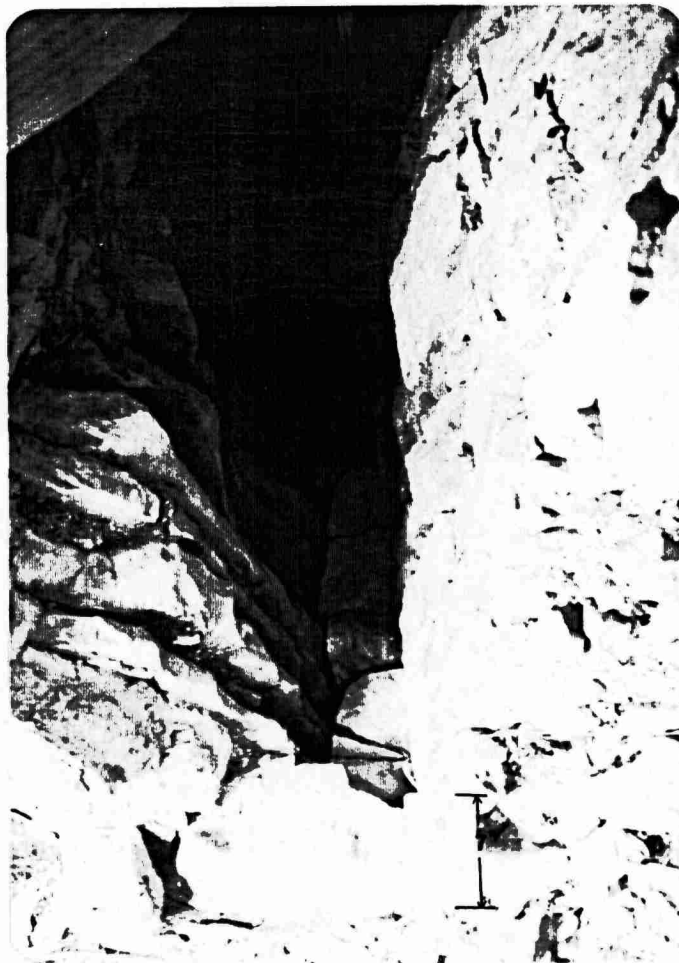


Plate 9. The Boulter spring viewed east to west has been excavated (about 2 m deep) into horizontally bedded dolomite.



Plate 10. Vertical crevasses and fractures are commonly found in the exposed dolomite. The main fracture patterns here are from NE to SW and from NW to SE.

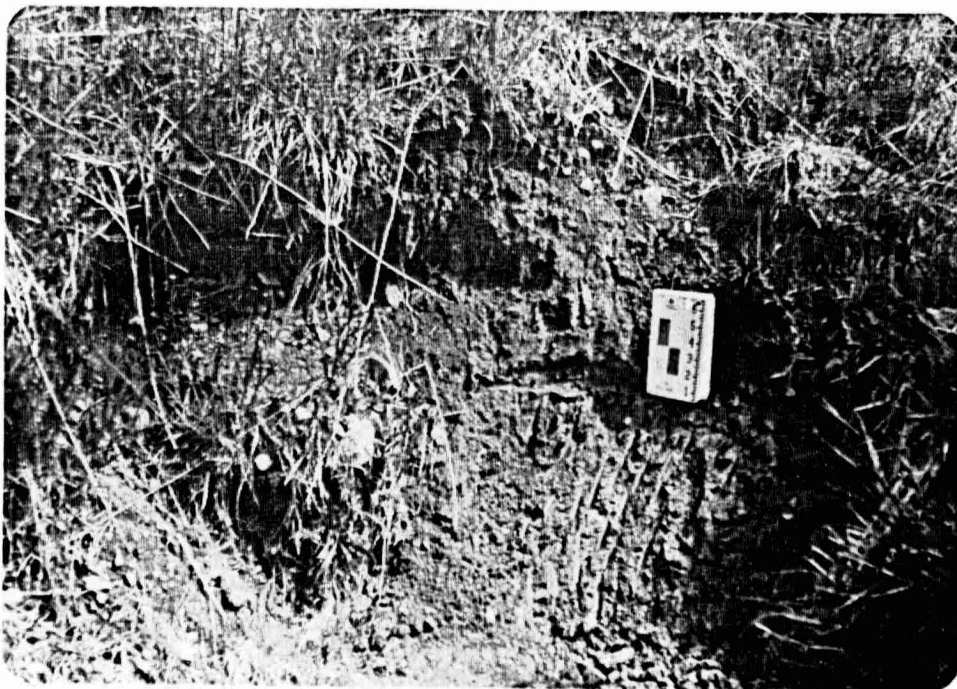


Plate 11. Erosion has exposed silty clay till deposits overlain by a thin veneer of silt, sand, and gravel. Point at the northeastern corner of the Wiarton sewage lagoon.

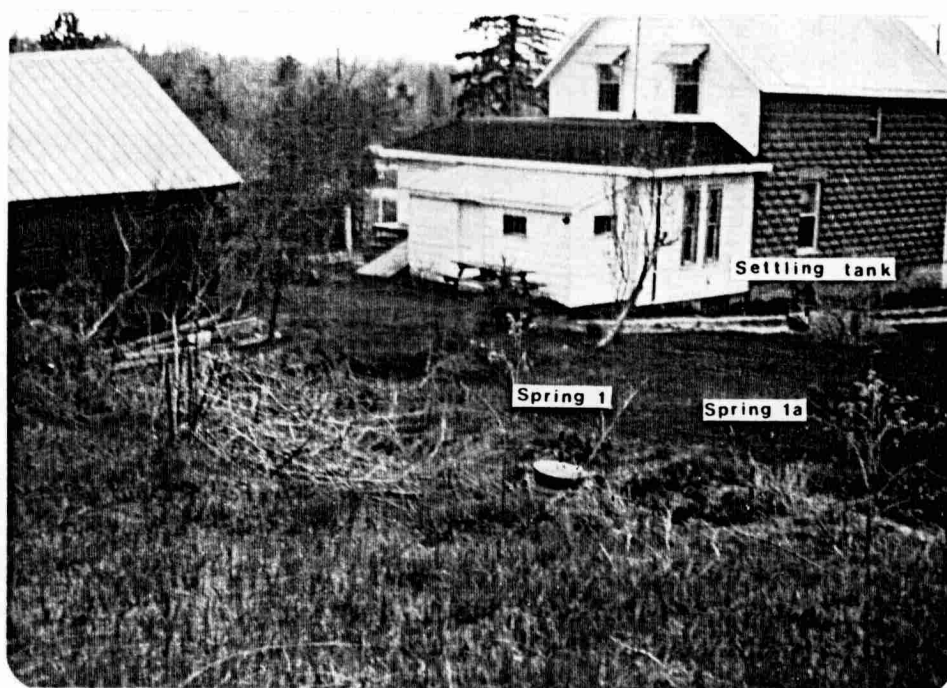


Plate 12. Looking northwest; the erosion channel which originates at the Armstrong springs and which has been developed during high flow from spring 1a.

APPENDIX A

SUMMARY OF WATER WELL RECORDS



Ministry of the  
Environment

# SUMMARY OF WATER WELL RECORDS

Southwestern Region

Technical Support Section

31/03/77

985 Adelaide St. South, London N6E 1V3

Compiler: C. Riediger & J. Owen

Ontario

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Well number <sup>1</sup>	Location			Elevation, in feet	Owner	Driller	Date drilled	Well diameter, in inches	Length of casing, in feet	Well depth, in feet	Depth water found, in feet	Original static level, in feet	Pumping test			Kind of water <sup>2</sup>	Water use <sup>3</sup>	Well log and remarks
	Township	Lot	Concession										Drawdown, in feet	Pumping rate, in l/gpm	Duration of pumping, hrs			
1600	K	2	21	665	S. WYONCH R. HELLYER (PRESENT OWNER)	ROY AND STANLEY WRIGHT	12/09/61	4.25	9.5	90	86	10	65	03	0.5	SA		SILT 0-3 LIMESTONE 3-45 WELL SHALES 45-48 ABANDONED LIMESTONE 48-64 SHALES 64-90
3720	"	3	"	682	J. CAMPBELL	A. WRIGHT	25/11/71	5	20	90		30	60+	0	-	FR		CLAY AND STONE 0-16 WHITE LIMESTONE 16-75 BLUE SHALE 75-85 RED SHALE 85-90
4528	"	"	"	695	G. SCHROEDER	D. WRIGHT	07/01/74	5	16	95	45	34	61	01	-	FR		SOIL 0-7 ROCK 7-68 BLUE SHALE 68-86 RED SHALE 86-95
4529	"	"	"	700	G. SCHROEDER	D. WRIGHT	07/01/74	5	12	100	48	38	57+	1	1	FR		SOIL 0-5 BEDROCK 5-89 BLUE AND RED SHALE 89-100
5534	"	4	"	703	M. NIXON A. HURLBURT (PRESENT OWNER)	W. WRIGHT	29/09/75	6.25	31	115	103	40	70	5	2	SLIGHT MN		LIMESTONE 0-90 BLUE SHALE 90-107 BLUE AND RED SHALE 107-115
5047	"	7	22	726	B. KEITH	D. WRIGHT	17/01/75	5	21	44	26	7	11	6	1	FR		SOIL 0-3 CLAY AND STONES 3-17 BEDROCK 17-44
1	K	2	21		TOWN OF WIARTON WELL AT THE BASE OF LAGOON					~6								NO WATER WELL RECORD AVAILABLE SHALLOW BEDROCK WELL
2	"	2	"		G. VABSHOTT					7								SHALLOW BEDROCK WELL
3	"	2	"	665	R. HELLYER			4		223		10.1						SHALLOW BEDROCK WELL

<sup>1</sup> Location is shown in Figure . <sup>2</sup> FR - fresh; SA - salty; SU - sulphur; MN - mineral. <sup>3</sup> DO - domestic; ST - stock; IR - irrigation; IN - industry; CO - commercial; MU - municipal  
PS - public supply; CA - Cooling or air conditioning.

-50-



Ministry of the  
Environment

Ontario

County: Grey, Bruce

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Date compiled: 09/03/78

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

Compiler: C. Riediger & J. Owen

Well number <sup>1</sup>	Location			Elevation, in feet	Owner	Driller	Date drilled	Well diameter, in inches	Length of casing, in feet	Well depth, in feet	Depth water found, in feet	Original static level, in feet	Pumping test			Kind of water <sup>2</sup>	Water use <sup>3</sup>	Well log and remarks
	Township	Lot	Concession										Drawdown, in feet	Pumping rate, in lpm	Duration of pumping, hrs			
4	K	4	21		WELL IN THE FIELD EAST OF BOULTER HOME													SHALLOW BEDROCK WELL
5	"	5	"		J. SYMON TENANT A. WARD OWNER													SHALLOW BEDROCK WELL
6	"	6	"		J. BROWN TENANT A. THOMPSON OWNER													SHALLOW BEDROCK WELL
7	W				G. CUNNINGHAM			4		85		11.65 APR. 27/77						BEDROCK WELL
SPRINGS																		
1	K	2	21		MRS. G. ARMSTRONG													SHALLOW BEDROCK
1A	"	"	"		MRS. G. ARMSTRONG													SHALLOW BEDROCK
2	"	4	"		R. BOULTER													SHALLOW BEDROCK
3	"	2	21		SPRING NW OF WIARTON SEWAGE LAGOON													SHALLOW BEDROCK

<sup>1</sup> Location is shown in Figure . <sup>2</sup> FR - fresh; SA - salty; SU - sulphur; MN - mineral. <sup>3</sup> DO - domestic; ST - stock; IR - irrigation; IN - industry; CO - commercial; MU - municipal

PS - public supply; CA - Cooling or air conditioning .



Ministry of the  
Environment

Ontario

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Township(s): Keppel, Wiarton

31/03/77

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Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

Compiler: C. Riediger & J. Owen

Well number <sup>1</sup>	Location			Elevation, in feet	Owner	Driller	Date drilled	Well diameter, in inches	Length of casing, in feet	Well depth, in feet	Depth water found, in feet	Original static level, in feet	Pumping test			Kind of water <sup>2</sup>	Water use <sup>3</sup>	Well log and remarks
	Township	Lot	Concession										Drawdown, in feet	Pumping rate, in l/gpm	Duration of pumping, hrs			
4	W																	BEDROCK SPRING; TOE OF THE ESCARPMENT
5	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT
6	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT
7	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT
8	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT
9	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT
10	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT
11	"																	BEDROCK SPRING; TOE OF THE ESCARPMENT

<sup>1</sup> Location is shown in Figure . <sup>2</sup> FR - fresh; SA - salty; SU - sulphur; MN - mineral. <sup>3</sup> DO - domestic; ST - stock; IR - irrigation; IN - industry; CO - commercial; MU - municipal  
PS - public supply; CA - Cooling or air conditioning .

APPENDIX B

LITHOLOGICAL LOGS OF TEST HOLES

LITHOLOGICAL LOGS OF TEST HOLES

Augered using power auger (3 inch in diameter)  
on November 3, 1977.

Test Hole 1

From	to	(meters)	
0	0.10		Top soil
0.10	1.52		Grey silty Clay till Dry

Test Hole 2

From	to	(meters)	
0	0.20		Sandy topsoil
0.20	0.65		Silty sand
0.65	0.95		Sandy clay (wet)
0.95	1.15		Dry grey clay
1.15	1.40		Grey clay (very wet)

Test Hole 3

From	to	(meters)	
0	0.54		Brown silty clay Dry

Test Hole 4

From	to	(meters)	
0	1.10		Top soil
0.10	1.30		Brown silty clay Dry

APPENDIX C

HYDROCHEMICAL MAPS AND  
THE PIPER DIAGRAM

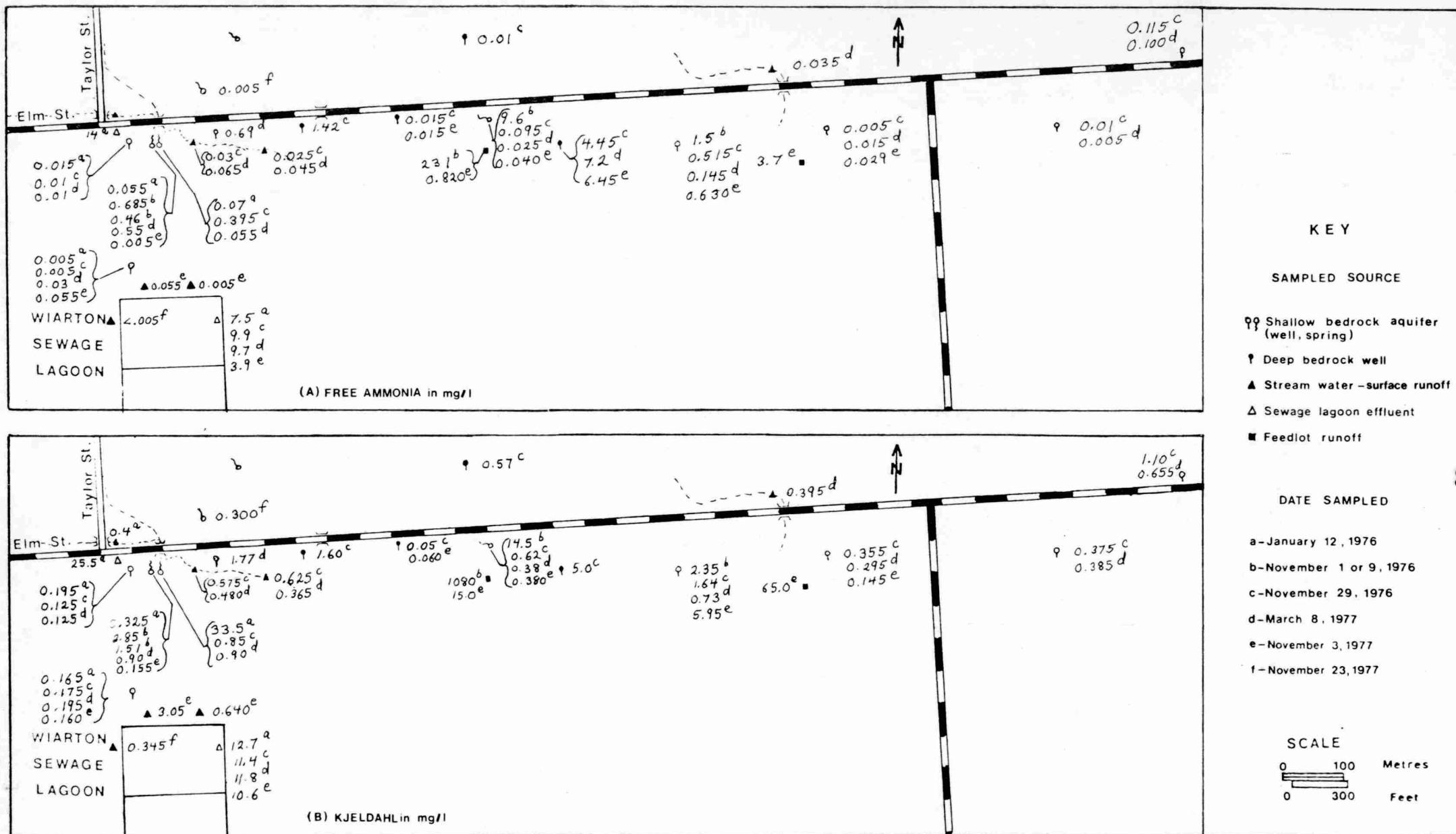


FIGURE 10. HYDROCHEMICAL MAP OF FREE AMMONIA (A) AND KJELDAHL (B) DISTRIBUTION IN GROUNDWATER, SURFACE WATER AND FEEDLOT RUNOFF.

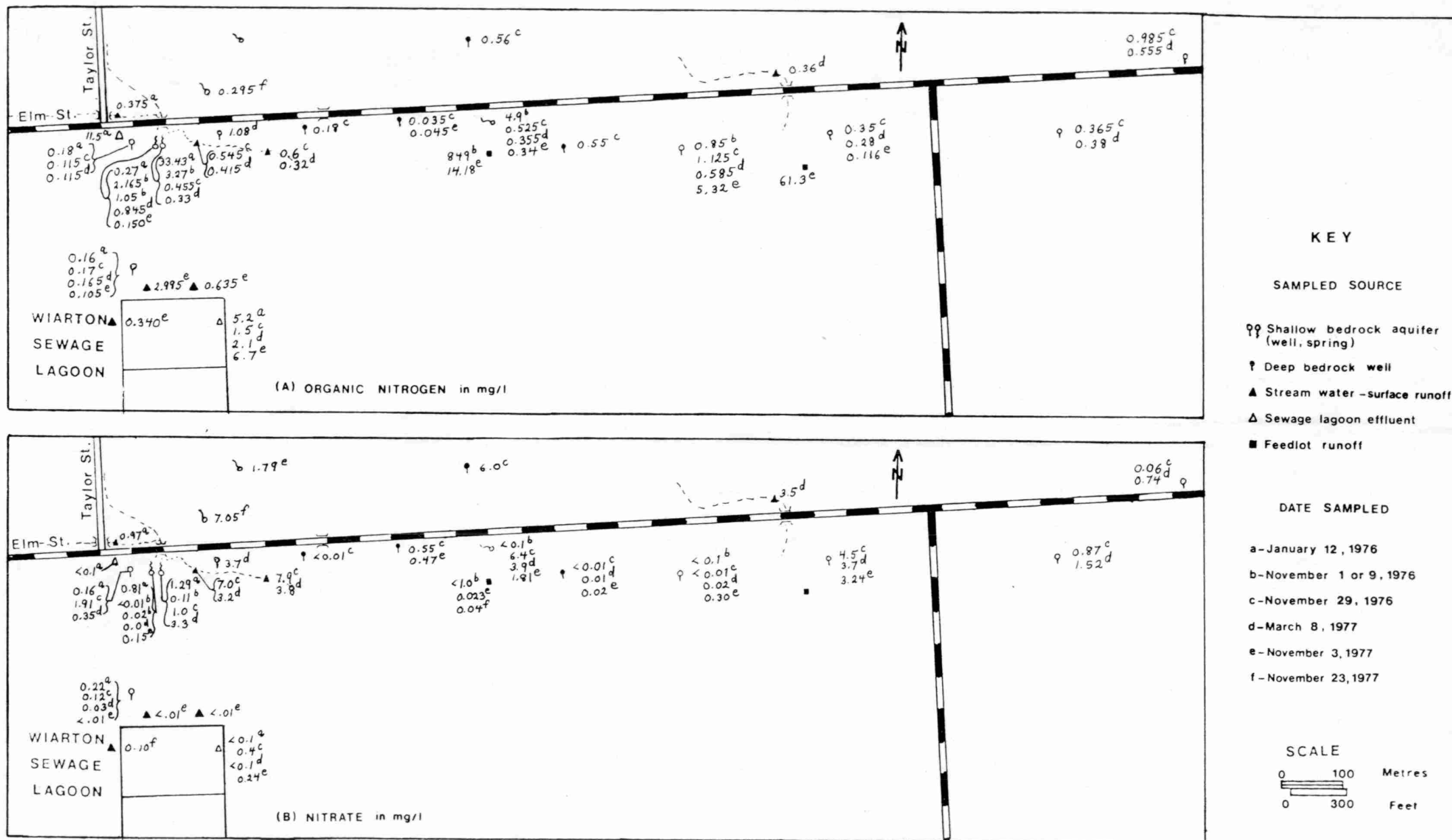


FIGURE 11. HYDROCHEMICAL MAP OF ORGANIC NITROGEN (A) AND NITRATE (B) DISTRIBUTION IN GROUNDWATER, SURFACE WATER AND FEEDLOT RUNOFF.

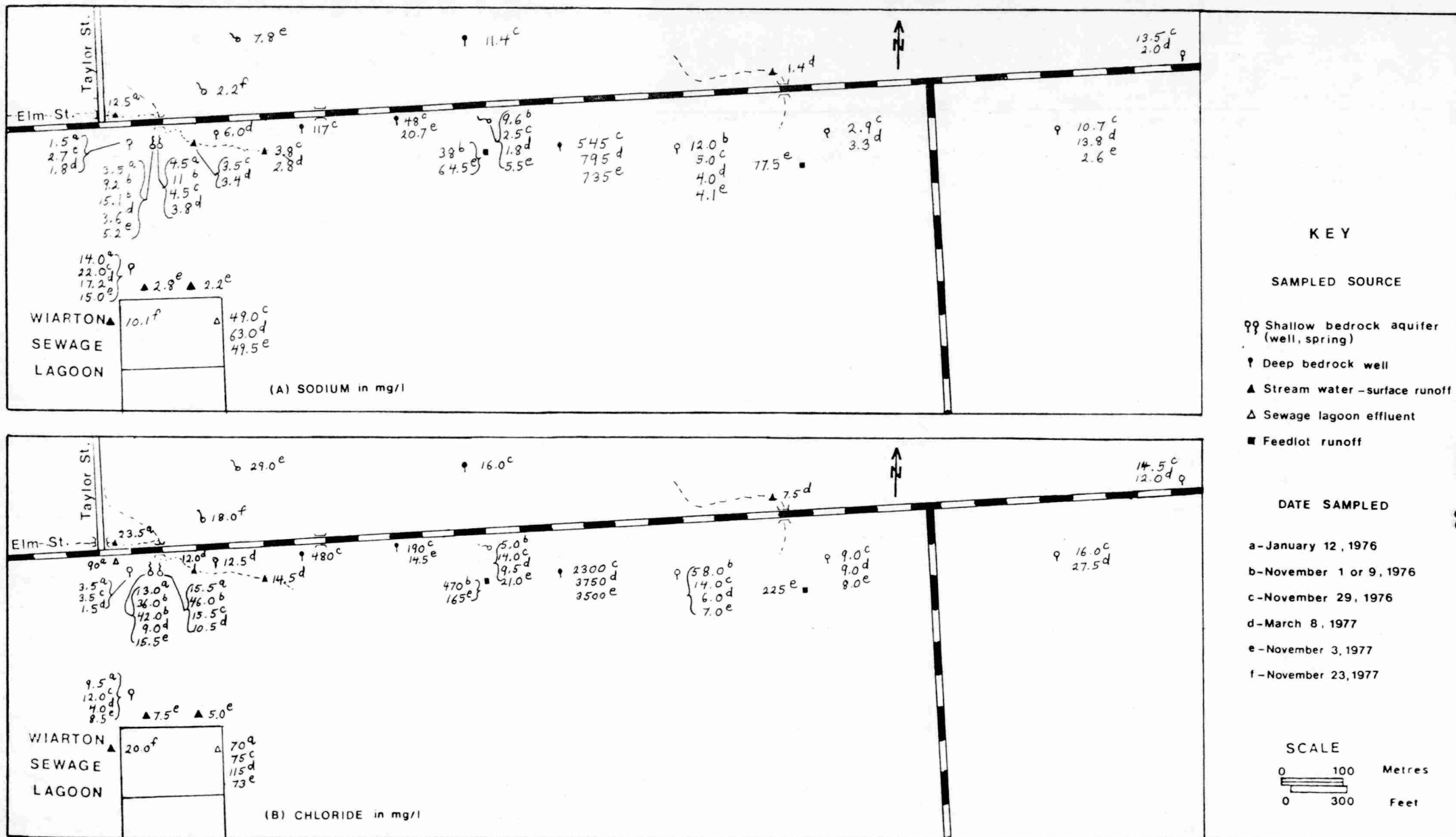


FIGURE 12. HYDROCHEMICAL MAP OF SODIUM (A) AND CHLORIDE (B) DISTRIBUTION IN GROUNDWATER, SURFACE WATER AND FEEDLOT RUNOFF.

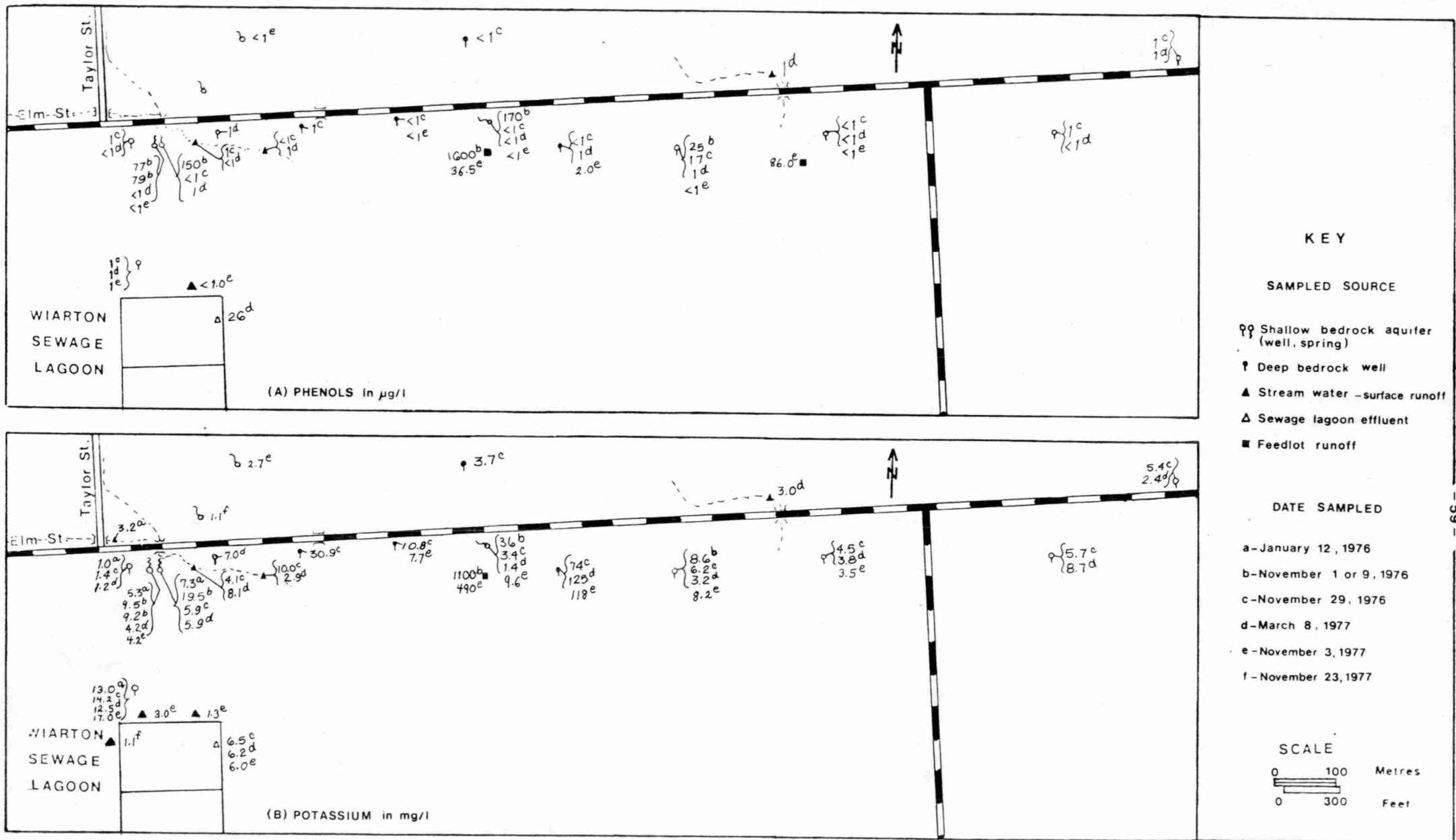
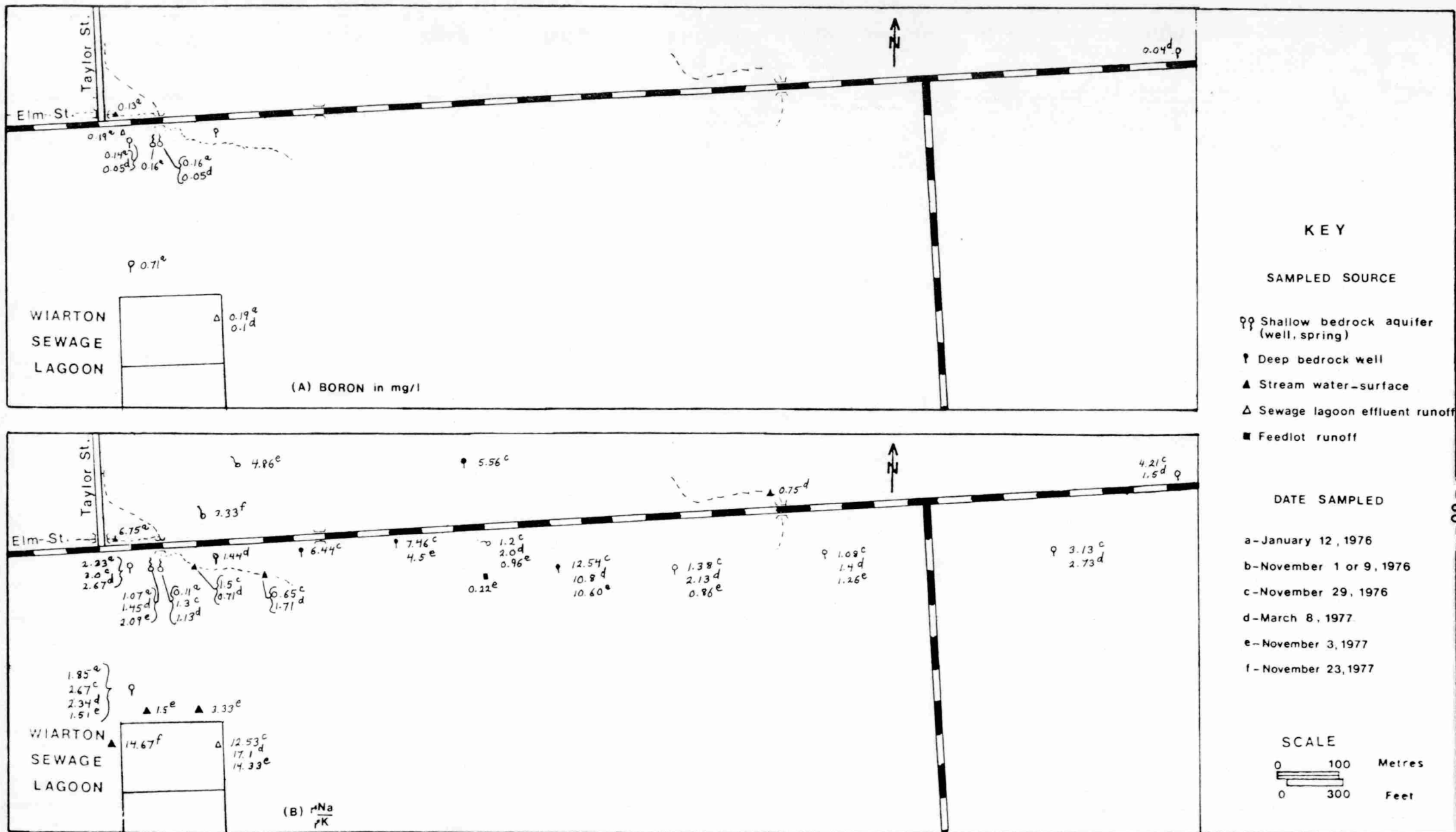
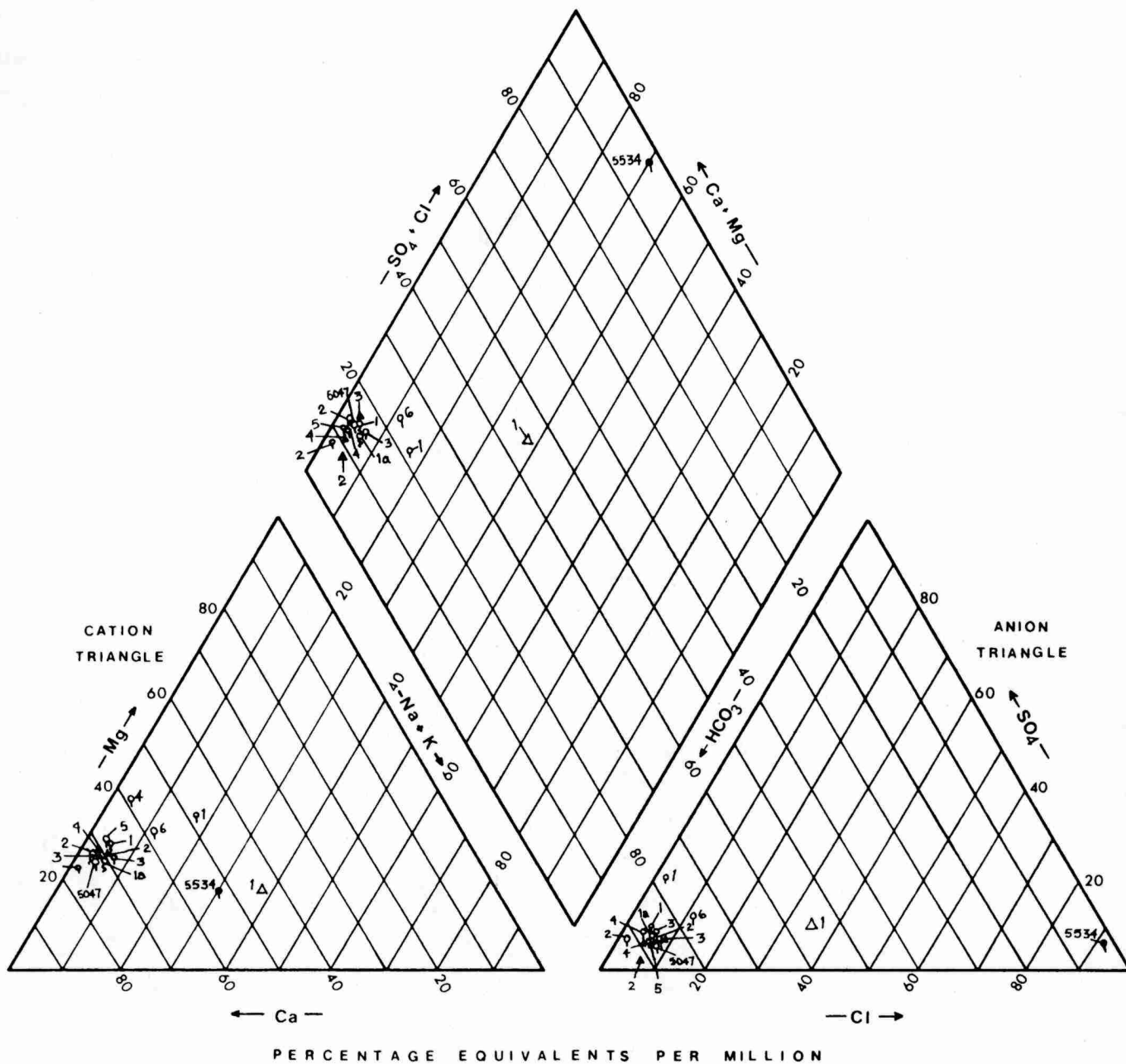


FIGURE 13. HYDROCHEMICAL MAP OF PHENOLS (A) AND POTASSIUM (B) DISTRIBUTION IN GROUNDWATER, SURFACE WATER AND FEEDLOT RUNOFF.



\* The notation r indicates that the ratios are calculated from equivalent parts per million

**FIGURE 14. HYDROCHEMICAL MAP OF BORON (A) AND Na/K RATIO (B) DISTRIBUTION IN GROUNDWATER, SURFACE WATER AND FEEDLOT RUNOFF.**



DATE SAMPLED: March 8, 1977

# KEY

## SAMPLED SOURCE

○ Shallow bedrock aquifer  
(well, spring)

● Deep bedrock aquifer

▲ Stream water - surface runoff

◈ Sewage lagoon effluent

Location of sampling points shown in Figure 1.

FIGURE 15. HYDROGEOCHEMISTRY OF GROUNDWATER, SURFACE WATER AND SEWAGE LAGOON EFFLUENT.

APPENDIX D

SUMMARY OF CHEMICAL ANALYSES  
OF GROUNDWATER



Ministry of the  
Environment

# SUMMARY OF CHEMICAL ANALYSES OF WATER

Southwestern Region  
Technical Support Section  
985 Adelaide St. South, London N6E 1V3

Ontario

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l	
		Concession	Lot																	Nitrite	Nitrate	Dissolved Reactive	Total			
																								Total Kjeldahl		Free Ammonia
1	Well at north end of sewage lagoon	K	Z	Z1	12/01/76	ppm	262	230	2.32	7.53	10	2.1	565	280.42	9.5	50	68	20.8	14.0	13.0	0.005	0.165	0.001	0.22	0.064	0.107
						eppm							4.6	0.27	1.04	3.39	1.71	0.61	0.33				0.02			
						% eppm							77.8	4.6	17.6	56.1	28.3	10.1	5.5							
"	"	"	"	"	23/02/76	ppm	288	221	2.04	7.47			269.45	7.0	60	86	19.8	3.6	21.5	0.005	0.145	0.001	5.9	0.069	0.144	
						eppm							4.42	0.20	1.25	4.29	1.63	0.16	0.94				0.42			
						% eppm							75.3	3.4	21.3	61.1	23.2	2.3	13.4							
"	"	"	"	"	29/01/76	ppm	270	224	1.64	7.51				12.0	90			22.0	14.2	0.005	0.175	0.001	0.12	0.04	0.093	1
						eppm																				
						% eppm																				
"	"	"	"	"	08/03/77	ppm	258	238	1.46	7.73		600	290.17	4.0	60.0	62.0	25.2	17.2	12.5	0.03	0.195	0.003	0.03	0.049	0.141	41
						eppm							4.76	0.11	1.25	3.09	2.07	0.75	0.32							
						% eppm							77.8	1.8	20.4	49.6	33.2	12.0	5.1							
"	"	"	"	"	03/11/77	ppm	292	252	3.50	7.55			307	8.5	54	70.0	21.8	15.0	17.0	0.055	0.160	0.002	4.01	0.062	0.005	41.0
						eppm							5.03	0.24	1.12	3.49	1.79	0.65	0.43							
						% eppm							78.7	3.75	17.6	54.8	28.1	10.2	6.82							
						ppm																				
						eppm																				
						% eppm																				
						ppm																				
						eppm																				
						% eppm																				

<sup>1</sup>Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



Ontario

Ministry of the  
Environment

# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owe

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids																								
		Township	Lot	Concession				Inorganic	Organic	Total																																										
1	Well at north end of Sewage lagoon	K	2	21	17/01/76	0.2																																														
"	"	"	"	"	23/02/76																																															
"	"	"	"	"	29/01/76																																															
"	"	"	"	"	08/03/77		7.2																																													
"	"	"	"	"	03/01/77		21	58	2	60		0.5															10.7																									

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 ppb = 1 µg/l.



Ministry of the  
Environment

Ontario

# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number 1	Owner or Source	Location		Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance , in micromhos/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l		
		Concession	Lot Township																	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive	Total			
																										Free Ammonia	
2	G Urbshott	K	Z	Z1	12/01/76	ppm	260	230	0.02	7.6	45	0.15	475	280.42	3.5	25.5	83	12	1.5	1.0	0.015	0.195	40.001	0.16	0.002	0.003	
						epm								4.6	0.10	0.53	4.14	0.99	0.07	0.03				0.01			
						% epm								88.0	1.9	10.1	79.2	18.9	1.3	0.6							
"	"	"	"	"	23/02/76	ppm	240	214	0.01	7.58				310.9	3.0	16.5	81	11.3	1.5	1.0	0.015	0.245	0.001	0.42	0.003	0.047	
						epm								5.1	0.08	0.34	4.04	0.93	0.07	0.03				0.03			
						% epm								92.4	1.4	6.2	79.7	18.3	1.4	0.6							
"	"	"	"	"	29/11/76	ppm	264	255	0.04	7.4					3.5	38.5			2.7	1.4	0.01	0.125	0.001	1.91	0.001	0.003	1
						epm																					
						% epm																					
"	"	"	"	"	08/03/77	ppm	236	216	0.01	7.76			450	263.35	1.5	18.0	74.0	12.4	1.8	1.2	0.01	0.125	0.003	0.35	0.021	0.067	41
						epm								4.32	0.04	0.37	3.69	1.02	0.08	0.03				0.02			
						% epm								91.2	0.9	7.9	76.6	21.2	1.6	0.6							
						ppm																					
						epm																					
						% epm																					
3	R. Hellyer Well on east side of house	K	Z	Z1	08/03/77	ppm	260	221		7.56			540	269.45	12.5	20.0	75.0	15.0	6.0	7.0	0.69	1.77	0.119	3.7	0.051	0.099	1
						epm								4.42	0.35	0.41	3.74	1.23	0.26	0.18				0.26			
						% epm								85.2	6.8	8.0	69.1	22.8	4.8	33							
						ppm																					
						epm																					
						% epm																					
						ppm																					
						epm																					
						% epm																					

<sup>1</sup>Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



Ministry of the  
Environment

## SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owe

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids
		Concession	Lot	Township				Inorganic	Organic	Total																		
2	G Urbshott	K	Z	Z	12/01/76	0.10																			0.14			
"	"	"	"	"	23/02/76																							
"	"	"	"	"	29/11/76		71.8																					
"	"	"	"	"	08/03/77		23	54	1	55		0.5													0.05	4.01		
3	R. Hellyer well on east side of house	Z	Z	Z	08/03/77	64	57	3	60		0.5															4.01		

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 ppb = 1 µg/l.



Ministry of the  
Environment

Ontario

# SUMMARY OF CHEMICAL ANALYSES OF WATER

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31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number 1	Owner or Source	Location		Date Sampled YY/MM/DD	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Nitrogen as N				Phosphorus as P		Phenols, in µg/l	
		Concession	Lot																	Nitrate	Nitrite	Total Kjeldahl	Free Ammonia	Dissolved Reactive	Total		
3720	J Campbell	K	3	21	29/11/76	ppm	880	242	1.24	7.30				480	220			117	30.9	1.42	1.60	20.001	20.01	20.001	0.01	1	
						ePM																					
						% ePM																					
						ppm																					
						ePM																					
						% ePM																					
						ppm																					
						ePM																					
						% ePM																					
4528	G Schroeder	K	3	21	29/11/76	ppm	524	250	0.12	7.43				190	120			48	10.8	0.015	0.05	20.001	0.55	20.001	0.035	21	
						ePM																					
						% ePM																					
"	"	"	"	"	03/11/77	ppm	424	360	0.10	7.54			439	14.5	81	94.5	40.0	20.7	7.7	0.015	0.060	0.001	0.47	0.004	0.003	21.0	
						ePM							7.19	0.41	1.69	4.72	3.30	0.90	0.20				0.03				
						% ePM							77.4	4.40	18.2	51.8	36.1	9.89	2.16								
						ppm																					
						ePM																					
						% ePM																					
						ppm																					
						ePM																					
						% ePM																					
						ppm																					
						ePM																					
						% ePM																					

<sup>1</sup>Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



County: Grey, Bruce

All analyses except pH reported in mg/l unless otherwise indicated

**Township(s):** Keppel, Wiarton

## Technical Support Section

985 Adelaide St. South, London N6E 1V3

Date compiled: 31/03/77  
09/03/78 Compiler: C. Riediger & J. Owe

[illegible]

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 imp. gal; 1 ppb = 1 µg/l.



Ministry of the  
Environment

# SUMMARY OF CHEMICAL ANALYSES OF WATER

Southwestern Region  
Technical Support Section  
985 Adelaide St. South, London N6E 1V3

Ontario

All analyses except pH reported in mg/l unless otherwise indicated 31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78 Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l	
		Concession	Lot	Township																	Nitrate	Nitrite	Total Kjeldahl	Free Ammonia	Dissolved Reactive		Total
5534	A. Hurlburt (M. Nixon) owner	K	4	Z1	23/02/76	ppm	700	229	0.14	7.55				279.2	405	115	188	57	99	27.5	0.137	0.475	0.009	40.01	0.003	0.135	
						epm								4.8	11.43	2.39	9.38	4.69	4.31	0.70							
						% epm								24.9	62.1	13.0	49.2	24.6	22.6	3.7							
"	"	"	"	"	27/10/76	ppm	4600	88	3.5	7.03					4100						8.7		40.01	40.1	40.05		
						epm																					
						% epm																					
"	"	"	"	"	29/11/76	ppm	2700	162	2.0	7.33					2300	450			545	74	4.45	5.0	0.001	40.01	40.001	0.009	41
						epm																					
						% epm																					
"	"	"	"	"	08/03/77	ppm	4480	98.4	1.7	7.39		11800	119.97	3750	435	1280	280	795	125	7.2		0.005	0.01	0.002		1	
						epm							2.0	105.8	9.1	63.9	23.0	34.6	3.2								
						% epm							11.7	90.6	7.8	51.2	18.5	27.7	2.6								
"	"	"	"	"	03/11/77	ppm	3640	114	1.45	7.23			139	3500	590	1080	162	735	118	6.45		0.008	0.02		0.001	2.0	
						epm							2.28	98.7	12.3	53.9	13.3	32.0	3.02								
						% epm							2.01	87.1	10.8	52.7	13.0	31.3	2.95								
						ppm																					
						epm																					
						% epm																					
						ppm																					
						epm																					
						% epm																					
						ppm																					
						epm																					
						% epm																					

<sup>1</sup>Location is shown in Figure 1. ; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal ; 1ppb = 1µg/l.



County: Grey, Bruce

All analyses except pH reported in mg/l unless otherwise indicated

### Technical Support Section

985 Adelaide St. South, London N6E 1V3

Date compiled: 31/03/77  
09/03/78 Compiler: C. Riediger & J. Owen

[illegible]

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l=1 ppm=1lb/100,000 Imp. gal; 1ppb = 1µg/l.



# SUMMARY OF CHEMICAL ANALYSES OF WATER

Ontario

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number 1	Owner or Source	Location		Date Sampled D.M.Y.	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N				Phosphorus as P		Phenols, in µg/l	
		Concession	Lot																	Township	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive		Total
4	Well in field east of A. Hurlburt	K	4	Z1	09/11/76	ppm	460	372	11.0	6.78		1390	453.55	58.0	12.0	124	306	12.0	8.6	1.5	2.35	40.01	40.1	40.05	0.35	25	
					epm								7.43	1.64	0.25	6.19	2.52	0.52	0.22								
					% epm								79.7	17.6	2.7	65.5	26.7	5.5	2.3								
"	"	"	"	"	29/11/76	ppm	420	385	17.6	7.05				14.0	10			5.0	6.2	0.515	1.64	0.002	40.01	0.001	0.23	17	
					epm																						
					% epm																						
"	"	"	"	"	08/03/77	ppm	316	288	5.6	7.44		600	351.13	6.0	28.0	77.0	29.8	4.0	3.2	0.145	0.73	0.005	0.02	0.003	0.104	1	
					epm								5.75	0.17	0.58	3.84	2.45	0.17	0.08				0.001				
					% epm								88.4	2.6	9.0	58.7	37.4	2.7	1.2								
"	"	"	"	"	03/11/77	ppm	420	292	66.0	7.39			356	7.0	48.0	90.0	25.5	4.1	8.2	0.630	5.95	0.051	0.30	1.10	0.003	41.0	
					epm								583	0.20	1.00	4.49	2.10	0.18	0.21								
					% epm								83.0	2.81	14.2	64.4	30.1	2.56	3.01								
					ppm																						
					epm																						
					% epm																						
					ppm																						
					epm																						
					% epm																						
5	J Symon (A. Ward) owner	K	5	Z1	29/11/76	ppm	232	182	0.11	7.39				9.0	26			2.9	4.5	0.005	0.355	0.001	4.5	0.015	0.023	41	
					epm																						
					% epm																						
"	"	"	"	"	08/03/77	ppm	240	213	0.04	7.5		500	259.69	9.0	17.0	70.0	17.6	3.3	3.8	0.015	0.245	0.003	3.7	0.063	0.139	41	
					epm								4.26	0.25	0.35	3.49	1.45	0.14	0.10				0.26				
					% epm								87.5	5.2	7.3	67.4	27.9	2.8	1.9								
"	"	"	"	"	03/11/77	ppm	332	266	0.06	7.49			324	8.0	31.0	84.5	25.5	2.6	3.5	0.029	0.145	0.001	3.24	0.048	0.025	41.0	
					epm								5.31	2.26	6.45	4.21	2.30	1.13	0.90				0.23				
					% epm								85.9	3.65	10.4	64.7	32.2	1.74	1.37								

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1 µg/l.



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Ministry of the  
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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owe

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids
		Concession	Lot				Inorganic	Organic	Total																		
4	Well in field east of A. Hurlburt	K	4	21	09/11/76	110																				50	
"	"	"	"	"	29/11/76	162																					
"	"	"	"	"	08/03/77	20	73	1	74		0.5														4.01		
"	"	"	"	"	03/11/77																						
5	J. Symon (A. Word) owner	K	5	21	29/11/76	7.2																					
"	"	"	"	"	08/03/77	18	54	1	55		0.5														20.1		
"	"	"	"	"	03/11/77																						

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 ppb = 1 µg/l.



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# SUMMARY OF CHEMICAL ANALYSES OF WATER

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31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton(w)

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Phenols, in µg/l	Phosphorus as P		N	as	Nitrogen	Potassium as K	Sodium as Na	Magnesium as Mg	Calcium as Ca	Sulphate as SO <sub>4</sub>	Chloride as Cl	Bicarbonate as HCO <sub>3</sub>	Conductance, in micromhos/cm 25°C	Turbidity in Formazin Units	Apparent Colour, in Hazen Units	pH at lab	Iron as Fe	Alkalinity as CaCO <sub>3</sub>	Hardness as CaCO <sub>3</sub>	Units	Date Sampled	Location			Owner or Source	Identification Number <sup>1</sup>	
	Total	Dissolved Reactive																				Nitrate	Nitrite	Total Kjeldahl			Free Ammonia

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



Ministry of the  
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# SUMMARY OF CHEMICAL ANALYSES OF WATER

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Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton(w)

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Chemical Oxygen Demand (COD)	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids
		Concession	Lot Township				Inorganic	Organic	Total																		
6	J. Brown (A. Thompson) owner		K 6	21	29/11/76																						
"	"		" "	"	08/03/77						0.5																
7	G. Cunningham		W		29/11/76																						

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 µg/l = 1 ppb.



Ministry of the  
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# SUMMARY OF CHEMICAL ANALYSES OF WATER

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31/03/77

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Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Phenols, in µg/l	Phosphorus as P		N Nitrate	as Nitrite	Nitrogen Total Kjeldahl	Free Ammonia	Potassium as K	Sodium as Na	Magnesium as Mg	Calcium as Ca	Sulphate as SO <sub>4</sub>	Chloride as Cl	Bicarbonate as HCO <sub>3</sub>	Conductance, in micromhos/cm 25C	Turbidity in Formazin Units	Apparent Colour, in Hazen Units	pH at lab	Iron as Fe	Alkalinity as CaCO <sub>3</sub>	Hardness as CaCO <sub>3</sub>	Units	Date Sampled	Location		Owner or Source	Identification Number <sup>1</sup>	
	Total	Dissolved Reactive																					Concession	Lot			Township
1	0.015	20.001	0.06	0.002	1.10	0.115	5.4	13.5			73	14.5					7.34	1.04	286	352	ppm	29/11/76	22	7	K	B. Keith	5047
1	0.043	0.022	0.74	0.021	0.655	0.100	2.4	2.0	11.8	66.0	11.0	12.0	235.31	435			7.67	0.3	193	216	ppm	08/03/77				"	"
			0.05				0.06	0.09	0.97	3.29	0.23	0.34	3.86								epm						
							1.4	2.0	22.0	74.6	5.2	7.7	87.2								% epm						
																					ppm						
																					epm						
																					% epm						
																					ppm						
																					epm						
																					% epm						
																					ppm						
																					epm						
																					% epm						
																					ppm						
																					epm						
																					% epm						
																					ppm						
																					epm						
																					% epm						

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb / 100,000 Imp. gal; 1 ppb = 1 µg/l.





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County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in microhm/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N				Phosphorus as P		Phenols, in µg/l
		Township	Lot	Concession																	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive	Total	
Spring 1	Mrs. G. Armstrong Sp: captured spring	K	Z	Z1	24/11/75	ppm			7.2												0.005	1.11	0.004	40.01	0.001	0.162	
						eppm																					
						% eppm																					
"	Sp: settling tank	"	"	"	"	ppm	448		6.0						26.5	10	122		6.8	7.6	0.03	0.695	0.007	40.01	0.004	0.105	
						eppm																					
						% eppm																					
"	"	"	"	"	15/12/75	ppm				7.66							80				0.375	0.805	0.118	0.86	0.003	0.02	41
						eppm																					
						% eppm																					
"	Sp: captured spring	"	"	"	12/01/76	ppm	300	254	1.18	7.31	15	5.5	570	309.68	13	35	85	19.8	3.5	5.3	0.055	0.325	0.021	0.81	0.003	0.019	
						eppm								5.08	0.37	0.73	4.24	1.63	0.15	0.14				0.06			
						% eppm								82.2	6.0	11.8	68.8	26.5	2.4	2.3							
"	Sp: kitchen tap	"	"	"	23/02/76	ppm	254	199	0.04	7.69				242.62	8.5	22	77	15	2.7	4.1	0.015	0.31	0.005	3.7	0.005	0.012	
						eppm								3.98	0.24	0.47	3.84	1.23	0.12	0.1				0.26			
						% eppm								85	5.1	9.8	72.6	23.3	2.3	1.9							
"	Sp: captured spring	"	"	"	01/11/76	ppm	460	376	7.7	7.26		81	880		36	15.5	129		9.2	9.5	0.685	2.85	0.002	40.01	0.004	0.298	77
						eppm																					
						% eppm																					
"	Sp: settling tank	"	"	"	"	ppm	460	383	1.7	7.36	150	33	880		42	10.0	124		15.1	9.2	0.46	1.51	0.004	0.02	0.004	0.154	79
						eppm																					
						% eppm																					
"	M.V. Baker Sp: kitchen tap	"	"	"	08/03/77	ppm	324	261	0.32	7.8			580	318.22	9.0	29.49	83.0	20.4	3.6	4.2	0.055	0.90	0.003	0.09	0.007	0.018	41
						eppm								5.22	0.25	0.614	4.14	1.68	0.16	0.11							
						% eppm								85.8	4.1	10.1	68.0	27.6	2.6	1.8							
"	Sp: captured spring	"	"	"	03/11/77	ppm	372	300	0.14	7.89				366	15.5	32.5	100	21.2	5.2	4.2	0.005	0.155	0.001	0.15	0.004	0.003	41
						eppm								6.00	0.44	0.68	5.00	1.74	0.23	0.11				0.01			
						% eppm								84.3	6.15	9.52	70.6	24.7	3.20	1.52							

<sup>1</sup> Location is shown in Figure 1. ; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb / 100,000 Imp. gal ; 1 ppb = 1 µg/l ; \*Sp = sampling point



Ministry of the  
Environment

Ontario

# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids
		Concession	Lot	Township				Total	Organic	Inorganic																		
Spring 1	Mrs. G. Armstrong sp: captured spring		Z	K	24/1/75	63																						
"	sp: Settling tank		"	"	"																							
"	"		"	"	15/12/75	0.1																						
"	sp: captured spring		"	"	12/10/76	0.3																						
"	sp: kitchen tap		"	"	23/02/76																							
"	sp: captured spring		"	"	01/11/76	130																						
"	sp: Settling tank		"	"	"	718																						
"	M.V. Baker sp: kitchen tap		"	"	08/03/77		12																					
"	sp: captured spring		"	"	03/11/77																							

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 µg/l = 1 ppb; \*Sp = sampling point



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# SUMMARY OF CHEMICAL ANALYSES OF WATER

Ontario

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l	
		Concession	Lot Township																	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive	Total	
					ppm																					
					epm																					
					% epm																					
					ppm																					
					epm																					
					% epm																					
Spring 1a	Mrs. G. Armstrong sp. open spring	K	Z	Z1	24/11/75	ppm		13.6												4.005	49	0.007	4.001	0.011	5.2	
					epm																					
					% epm																					
"	sp* open spring	"	"	"	12/01/76	ppm	312	305	205	7.29	250	1050	600	371.86	15.5	47	145	25.4	4.5	7.3	0.07	33.5	0.039	1.29	0.014	7.8
					epm									6.09	0.44	0.98	7.24	2.09	0.20	1.9						
					% epm									81.1	5.9	13.0	74.5	21.5	2.1	2.0						
"	"	"	"	"	23/02/76	ppm	234	187	0.19	7.65				227.99	8.0	18.5	75	13.7	2.7	5.3	0.005	0.285	0.001	5.7	0.033	0.059
					epm									3.74	0.23	0.39	3.74	1.13	0.12	0.14						
					% epm									85.8	5.3	8.9	72.9	22.0	2.3	2.7						
"	"	"	"	"	01/11/76	ppm	490	424		7.16	250	82	980			134										
					epm																					
					% epm																					
"	"	"	"	"	29/11/76	ppm	264	209	4.8	7.31				15.5	38.0			4.5	5.9	0.395	0.85	0.33	1.0	10.001	0.068	4.1
					epm																					
					% epm																					
"	"	"	"	"	08/03/77	ppm	256	218	0.32	7.65		520	265.79	10.5	20.0	76.0	15.4	3.8	5.9	0.055	0.90	0.003	0.09	0.007	0.018	4.1
					epm									4.36	0.30	0.42	3.79	1.27	0.15							
					% epm									85.9	5.8	8.2	70.6	23.6	3.1	2.8						
					ppm																					
					epm																					
					% epm																					

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb / 100,000 Imp. gal; 1 ppb = 1 µg/l; \*Sp = sampling point



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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids
		Concession	Lot	Township				Total	Organic	Inorganic																		
Spring 1a	Mrs. G. Armstrong sp: open spring		K	Z	Z1	24/11/75	775																					246
"	sp: open spring		"	"	"	12/01/76	9.4											0.16										
"	"		"	"	"	23/02/76																						
"	"		"	"	"	01/11/76	230																					25
"	"		"	"	"	29/11/76		15																				
"	"		"	"	"	08/03/77		30	58	1	59		0.5					0.05									20.1	

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1lb/100,000 Imp. gal; 1 µg/l = 1 ppb.; \*Sp = sampling point



Ministry of the  
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# SUMMARY OF CHEMICAL ANALYSES OF WATER

Southwestern Region  
Technical Support Section  
985 Adelaide St. South, London N6E 1V3

Ontario

All analyses except pH reported in mg/l unless otherwise indicated 31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Phenols, in µg/l	Phosphorus as P		N Nitrate	as Nitrite	Nitrogen Total Kjeldahl	Free Ammonia	Potassium as K	Sodium as Na	Magnesium as Mg	Calcium as Ca	Sulphate as SO <sub>4</sub>	Chloride as Cl	Bicarbonate as HCO <sub>3</sub>	Conductance, in micromhos/cm 25°C	Turbidity in Formazin Units	Apparent Colour, in Hazen Units	pH at lab	Iron as Fe	Alkalinity as CaCO <sub>3</sub>	Hardness as CaCO <sub>3</sub>	Units	Date Sampled	Location		Owner or Source	Identification Number 1						
	Total	Dissolved Reactive																					Concession	Lot								
																											Township					
17	0.6	0.004	6.0	0.066	0.5	0.115	2.3	1.5	13.2	75	21.0	10.0	207.21									23/02/76	21	4	K	R. Boulter spring	Spring Z					
																												ppm	226	170	0.07	7.51
																												epm				
							0.06	0.06	1.2	75.6	10.7	6.8	82.5									27/10/76										
																												ppm	960	762	48.8	6.31
																												epm				
170	2.0	40.05	40.1	0.03	14.5	9.6	36	9.6	41	157	26	5.0	598.63	1170								09/11/76										
																												ppm	580	491	23	6.81
																												epm				
41	0.067	0.013	6.4	0.149	0.62	0.095	3.4	2.5		32	14											29/11/76										
																												ppm	252	175	0.66	7.2
																												epm				
41	0.075	0.04	3.9	0.01	0.38	0.025	1.4	1.8	13.4	68.5	16.0	9.5	231.65	460								08/03/77										
																												ppm	232	190	0.2	7.60
																												epm				
41	0.045	0.052	1.81	0.003	0.380	0.040	9.6	5.5	26.0	95.0	33.5	21.0	341									03/11/77										
																												ppm	348	280	0.06	7.27
																												epm				

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D M Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids		
		Concession	Lot	Township				Inorganic	Organic	Total																				
Spring Z	R. Boulter spring		K 4	Z 1	23/02/76																									
"	"	"	"	"	27/02/76			150	800	950			6.2	1878																
"	"	"	"	"	09/01/76	410																						65		
"	"	"	"	"	29/01/76		14																							
"	"	"	"	"	08/03/77		18	51	1	52		0.5															20.1			
"	"	"	"	"	03/01/77																									

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 µg/l = 1 ppb.



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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton (w)

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l	
		Concession	Lot																	Nitrite	Nitrate	Dissolved Reactive	Total			
																								Free Ammonia		Total Kjeldahl
Spring 4	West Spring	W		23/11/77	ppm	324	251	0.50	7.43				306	18.0	25.0	94.0	18.8	2.2	1.1	0.005	0.300	0.001	7.05	0.039	0.060	
					epm								5.01	0.51	0.52	4.69	1.55	0.10	0.03				0.50			
					% epm								83.0	8.40	8.61	73.7	24.3	1.51	0.44							
					ppm																					
					epm																					
					% epm																					
					ppm																					
					epm																					
					% epm																					
Spring 6	Money Spring	W		03/11/77	ppm	432	337	20.1	7.78				411	29.0	50	120	31.6	7.8	2.7	0.120	0.005	2.001	1.79	0.011	0.011	41.0
					epm								6.73	0.82	1.04	5.99	2.60	0.34	0.07				0.13			
					% epm								78.4	9.52	12.1	66.6	28.9	3.77	0.77							
					ppm																					
					epm																					
					% epm																					
					ppm																					
					epm																					
					% epm																					
Spring 8	Bell Spring	W		03/11/77	ppm	368	333	0.02	7.75				406	3.0	18.0	100	24.2	1.7	1.2	0.190	0.005	0.001	0.25	0.024	0.033	1.0
					epm								6.65	0.08	0.37	5.00	2.00	0.07	0.03				0.02			
					% epm								93.5	1.19	5.27	70.4	28.1	1.04	0.43							
					ppm																					
					epm																					
					% epm																					
					ppm																					
					epm																					
					% epm																					

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



Ministry of the  
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## SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids
		Lot	Concession				Inorganic	Organic	Total																		
Spring 4	West spring	W		23/11/77																							
Spring 6	Money spring	W		03/11/77			93	1	94																		
Spring 8	Bell spring	W		03/11/77																							

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<sup>1</sup> Location is shown in Figure 1.; N.D. — Not Detected ; P — Present ; < — Refers to less than ; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal ; 1 µg/l = 1 ppb.

APPENDIX E

SUMMARY OF CHEMICAL ANALYSES  
OF STREAM WATER AND SURFACE RUNOFF



Ministry of the  
Environment

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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l	
		Lot	Concession																	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive		Total
1	Taylor Street Ditch	W		12/01/76	ppm	300	243	0.23	8.05	10	2.2	605	296.27	23.5	45	89	17.5	12.5	3.2	0.025	0.40	0.004	0.97	0.009	0.02	
					epm								4.86	0.66	0.94	4.44	1.44	0.54	0.08				0.07			
					% epm								75.2	10.2	14.6	68.3	22.2	8.3	1.2							
					ppm																					
					epm																					
					% epm																					
					ppm																					
					epm																					
					% epm																					
2	Intermittent Stream on R. Hillyer property	K	Z	Z1	29/11/76	ppm		0.3							30.0			3.5	4.1	0.03	0.575	0.029	7.0	0.02	0.087	1
					epm																					
					% epm																					
11	"	"	"	"	08/03/77	ppm	254	216	0.10	7.97		540	263.35	12.0	2.0	75.5	15.4	3.4	8.1	0.065	0.480	0.045	3.2	0.051	0.07	
					epm								4.32	0.34	0.04	3.77	1.27	0.15	0.21				0.23			
					% epm								91.9	7.2	0.9	69.9	23.5	2.7	3.8							
					ppm																					
					epm																					
					% epm																					
					ppm																					
					epm																					
					% epm																					
3	Intermittent Stream on B. Thorn property	K	3	Z1	29/11/76	ppm		0.25							30.0			3.8	10.0	0.025	0.625	0.012	7.9	0.053	0.085	41
					epm																					
					% epm																					
11	"	"	"	"	08/03/77	ppm	248	202	0.08	7.79		500	246.28	14.5	19.0	72.0	14.8	2.8	2.9	0.045	0.365	0.007	3.8	0.041	0.063	1
					epm								4.04	0.41	0.40	3.59	1.22	0.12	0.07				0.27			
					% epm								83.4	8.5	8.2	71.8	24.3	2.4	1.5							

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.



Ministry of the  
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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

31/03/77

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

County: Grey, Bruce

Township(s): Keppel, Wiarton

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D M Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids			
		Concession	Lot Township				Total	Organic	Inorganic																					
1	Taylor Street Ditch		W	12/01/76																				0.13						
Z	Intermittent stream on R. Hellyer property	Z1	K 2	29/11/76		16																								
"	"	"	"	08/03/77		20	54	Z	56		0.5																			
3	Intermittent stream on B. Thorn property	Z1	K 3	29/11/76		13																								
"	"	"	"	08/03/77		7.0	50	Z	52		0.5																			

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 µg/l = 1 ppb.



# SUMMARY OF CHEMICAL ANALYSES OF WATER

Southwestern Region  
Technical Support Section  
985 Adelaide St. South, London N6E 1V3

Ontario

All analyses except pH reported in mg/l unless otherwise indicated 31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Nitrogen as N			Phosphorus as P		Phenols, in µg/l
		Concession	Lot	Township																	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive	Total	
						ppm																				
						epm																				
						% epm																				
						ppm																				
						epm																				
						% epm																				
4	Intermittent Stream north of W. Ward on north side of Con. 21 Road	K	5	22	08/03/77	ppm	256	215	0.1	7.68		495	262.13	7.5	17.5	71.0	16.0	1.4	3.0	0.035	0.395	0.006	3.5	0.045	0.081	1
						epm							4.30	0.21	0.36	3.54	1.32	0.06	0.08			0.25				
						% epm							88.2	4.3	7.5	70.9	26.3	1.2	1.5							
						ppm																				
						epm																				
						% epm																				
						ppm																				
						epm																				
						% epm																				
5	Surface Water west side cell 1	K	Z	Z1	23/11/77	ppm	372	517		7.50			630	20.0	9.0	145	39.6	10.1	1.1	4.005	0.345	0.001	0.10	0.003	0.018	
						epm							10.3	0.56	0.19	7.24	3.26	0.44	0.03				1007			
						% epm							93.2	5.09	1.70	66.0	29.7	4.01	0.26							
						ppm																				
						epm																				
						% epm																				
						ppm																				
						epm																				
						% epm																				
7	Surface Water NW of Lagoon	K	Z	Z1	03/11/77	ppm	348	334		7.71			407	7.5	23.0	102	22.5	2.8	3.0	0.055	3.05	0.003	4.01	0.007	0.770	
						epm							6.67	0.21	0.48	5.09	1.85	0.12	0.08							
						% epm							90.6	2.87	6.50	71.3	25.9	1.71	1.07							

<sup>1</sup> Location is shown in Figure 1. ; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal ; 1ppb = 1 µg/l .



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# SUMMARY OF CHEMICAL ANALYSES OF WATER

All analyses except pH reported in mg/l unless otherwise indicated

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77

09/03/78 Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids			
		Concession	Lot				Inorganic	Organic	Total																					
4	Intermittent Stream north of W. Ward on north side of Con. 21 Road	K	5	22	08/03/77	7.0	54	2	56		0.5																			
5	Surface Water West side cell 1	K	2	21	23/11/77																									
7	Surface Water NW of Lagoon	K	2	21	03/11/77																									

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 µg/l = 1 ppb.



Ministry of the  
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# SUMMARY OF CHEMICAL ANALYSES OF WATER

Ontario

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Phenols, in µg/l	Phosphorus as P		N	as N	Nitrite	Total Kjeldahl Nitrogen	Free Ammonia	Potassium as K	Sodium as Na	Magnesium as Mg	Calcium as Ca	Sulphate as SO <sub>4</sub>	Chloride as Cl	Bicarbonate as HCO <sub>3</sub>	Conductance, in micromhos/cm 25C	Turbidity in Formazin Units	Apparent Colour, in Hazen Units	pH at lab	Iron as Fe	Alkalinity as CaCO <sub>3</sub>	Hardness as CaCO <sub>3</sub>	Units	Date Sampled	Location			Owner or Source	Identification Number <sup>1</sup>	
	Total	Dissolved Reactive																						Concession	Lot	Township			
41.0	0.024	0.003	4.01	0.003	0.003	0.640	0.005	1.3	2.2	28.3	92.5	17.5	5.0	3.78				7.99			348		03/11/77		Z1	Z	K	Surface water NE of Lagoon	0
								0.03	0.10	2.33	4.62	0.36	0.14	6.19															
								0.47	1.35	32.9	65.3	5.44	2.11	92.5															
																					</								

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.





# SUMMARY OF CHEMICAL ANALYSES OF WATER

Ontario

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

Southwestern Region

Technical Support Section

985 Adelaide St. South, London N6E 1V3

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Nitrogen as N				Phosphorus as P		Phenols, in µg/l
		Concession	Lot	Township																	Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive	Total	
1	Well pit W. Ward	K	5	21	29/11/76	ppm	120	86.4	4.0	7.58					4.0	12.0			2.1	4.0	0.095	0.67	0.017	0.74	0.12	0.262	1
						epm																					
						% epm																					
						ppm																					
						epm																					
						% epm																					
						ppm																					
						epm																					
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						epm																					
						% epm																					

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb / 100,000 Imp. gal; 1 ppb = 1 µg/l.



APPENDIX F

SUMMARY OF CHEMICAL ANALYSES  
OF SEWAGE LAGOON EFFLUENT



# SUMMARY OF CHEMICAL ANALYSES OF SEWAGE LAGOON EFFLUENT

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Turbidity in Formazin Units	Conductance, in microhm/cm 25°C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N				Phosphorus as P		Phenols, in µg/l
		Concession	Lot	Township																Free Ammonia	Total Kjeldahl	Nitrite	Nitrate	Dissolved Reactive	Total	
I	Warton Sewage Lagoon Cell #1	K	Z	Z1	12/01/76	ppm				7.38				70						7.5	12.7	0.03	40.1	1.4	2.3	
						epm																				
						% epm																				
II	"	"	"	"	23/02/76	ppm	264	237	0.4	7.24			289	97	42	80	18.0	52	6.4	8.5	9.75	0.01	40.1	1.35	1.75	
						epm							4.74	2.74	0.87	3.99	1.48	2.26	0.16							
						% epm							56.8	32.8	10.4	50.6	18.8	28.6	2.0							
II	"	"	"	"	29/11/76	ppm		226	0.6	7.55			275.5	75	49	72	16.4	49	6.5	9.9	11.4	0.05	0.4	1.75	2.6	
						epm							4.52	2.12	1.02	3.59	1.35	2.13	0.17							
						% epm							59.0	27.7	13.3	49.6	18.6	29.4	2.3							
II	"	"	"	"	08/03/77	ppm	252	237	0.44	7.18		900	288.95	115	42.0	68.0	18.0	63.0	6.2	9.7	11.8	0.01	40.1	1.75	1.95	26
						epm							4.74	3.24	0.87	3.39	1.48	2.74	0.16							
						% epm							53.5	36.6	9.9	43.7	19.0	35.3	2.0							
"	"	"	"	"	03/11/77	ppm	320	236	0.62	7.84			288	73.0	35.0	71.0	34.6	49.5	6.0	3.9	10.6	0.153	0.24	0.70	2.12	16
						epm							4.72	2.06	0.73	3.54	2.85	2.15	0.15							
						% epm							62.8	27.4	9.71	40.7	32.7	24.8	1.76							
						ppm																				
						epm																				
						% epm																				
						ppm																				
						epm																				
						% epm																				
Z	Warton Sewage Lagoon final effluent	K	Z	Z1	23/02/76	ppm	256	245	0.44	7.41			298.71	90	45	76.5	17.9	50	6.6	9.2	11.5	0.01	40.1	1.85	2.4	
						epm							4.9	2.54	0.94	3.82	1.47	2.18	0.17							
						% epm							58.5	30.3	11.2	50	19.2	28.5	2.2							
						ppm																				
						epm																				
						% epm																				

<sup>1</sup>Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal ; 1ppb = 1µg/l .



Ministry of the  
Environment

# SUMMARY OF CHEMICAL ANALYSES OF SEWAGE LAGOON EFFLUENT

Ontario

All analyses except pH reported in mg/l unless otherwise indicated

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78 Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids	
		Concession	Lot	Township				Total	Organic	Inorganic																			
I	Warton Sewage Lagoon - Cell #1		Z	K	12/01/76	16																			0.19		32		
II	"		"	"	23/02/76	13																					7.0		
A	"		"	"	29/11/76	12	61																				16		
11	"		"	"	08/03/77		86	67	16	83		3													0.1		-99-		
11	"		"	"	03/10/77																								
Z	Warton Sewage Lagoon - final effluent		Z	K	23/02/76	21.4																					7.5		

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected; P - Present; < - Refers to less than; 1 mg/l = 1 ppm = 1 lb/100,000 Imp. gal; 1 ppb = 1 µg/l.



Ministry of the  
Environment

Ontario

# SUMMARY OF CHEMICAL ANALYSES OF SEWAGE LAGOON EFFLUENT

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78

Compiler: C. Riediger & J. Owen

Phenols, in µg/l	Phosphorus as P		N	as	Nitrogen	Potassium as K	Sodium as Na	Magnesium as Mg	Calcium as Ca	Sulphate as SO <sub>4</sub>	Chloride as Cl	Bicarbonate as HCO <sub>3</sub>	Conductance, in micromhos/cm 25°C	Turbidity in Formazin Units	Apparent Colour, in Hazen Units	pH at lab	Iron as Fe	Alkalinity as CaCO <sub>3</sub>	Hardness as CaCO <sub>3</sub>	Units	Date Sampled	Location			Owner or Source	Identification Number 1				
	Total	Dissolved Reactive																				Nitrate	Nitrite	Total Kjeldahl			Free Ammonia	Concession	Lot	Township
																				ppm										
																				eppm										
																				% eppm										
																7.33				ppm	12/01/76	Z1	2	K	3					
																				eppm										
																				% eppm										
																				ppm										
																				eppm										
																				% eppm										
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																				% eppm										

<sup>1</sup> Location is shown in Figure 1.; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal; 1ppb = 1µg/l.

APPENDIX G

SUMMARY OF CHEMICAL ANALYSES  
OF FEEDLOT RUNOFF



Ministry of the  
Environment

Ontario

# SUMMARY OF CHEMICAL ANALYSES OF FEEDLOT RUNOFF

All analyses except pH reported in mg/l unless otherwise indicated

31/03/77

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 09/03/78 Compiler: C. Riediger & J. Ower

Identification Number 1	Owner or Source	Location			Date Sampled D/M/Y	Units	Hardness as CaCO <sub>3</sub>	Alkalinity as CaCO <sub>3</sub>	Iron as Fe	pH at lab	Apparent Colour, in Hazen Units	Turbidity in Formazin Units	Conductance, in micromhos/cm 25C	Bicarbonate as HCO <sub>3</sub>	Chloride as Cl	Sulphate as SO <sub>4</sub>	Calcium as Ca	Magnesium Mg as	Sodium as Na	Potassium as K	Nitrogen as N				Phosphorus as P		Phenols, in µg/l
		Township	Lot	Concession																	Nitrate	Nitrite	Total Kjeldahl	Free Ammonia	Dissolved Reactive	Total	
1	From open silo - R. Boulter	K	4	Z1	09/11/76	ppm		2530	56.5	4.87			12,500	3084.6	470	350	292	535	38.0	1100	231	1080	0.61	41.0	118	200	1600
						epm								50.56	13.26	7.29	14.57	44.01	1.65	28.13							
						% epm								71.1	18.6	10.3	16.5	49.8	1.9	31.8							
"	"	"	"	"	03/11/77	ppm	550	1110	20.0	8.26				1353	165	17.5	86.5	81.0	64.5	490	0.820	15.0	0.007	0.023	3.75	10.0	36.5
						epm								22.2	4.65	0.37	4.32	6.66	2.81	12.5				0.002			
						% epm								81.5	17.1	1.35	16.40	25.3	10.7	47.6							
						ppm																					
						epm																					
						% epm																					
Z	From feedlot - W. Ward	K	5	Z1	27/10/76	ppm				4.34					135						0.7	355	0.27	2.8	40.05	85.0	
						epm																					
						% epm																					
"	"	"	"	"	03/11/77	ppm	580	1020	29.0	7.76				1244	225	30	87.5	87.7	77.5		3.7	65.0	0.112	0.04	12.8	20.0	86
						epm																					
						% epm																					
						ppm																					
						epm																					
						% epm																					
						ppm																					
						epm																					
						% epm																					

<sup>1</sup> Location is shown in Figure 1. ; N.D. - Not detected; < - Refers to less than; 1 mg/l = 1 ppm = 1lb / 100,000 Imp. gal ; 1ppb = 1µg/l .



Ministry of the  
Environment

Ontario

# SUMMARY OF CHEMICAL ANALYSES OF FEEDLOT RUNOFF

All analyses except pH reported in mg/l unless otherwise indicated

County: Grey, Bruce

Township(s): Keppel, Wiarton

Date compiled: 31/03/77  
09/03/78 Compiler: C. Riediger & J. Owen

Identification Number <sup>1</sup>	Owner or Source	Location		Date Sampled D/M/Y	Biochemical Oxygen Demand (BOD <sub>5</sub> )	Chemical Oxygen Demand (COD)	Carbon			Petroleum Hydrocarbons	Tannins and Lignins	Reactive Silicate as Si	Total Dissolved Solids	Selenium as Se	Arsenic as As	Barium as Ba	Cadmium as Cd	Chromium as Cr	Copper as Cu	Cyanide as CN	Lead as Pb	Manganese as Mn	Nickel as Ni	Zinc as Zn	Boron as B	Anionic Detergent as A.B.S.	Suspended Solids																					
		Concession	Lot				Inorganic	Organic	Total																																							
1	From open silo - R. Boulter	K 4	Z1	09/11/76	41,500																						2152																					
"	"	"	"	03/11/77																																												
Z	From feedlot - W. Word	K 5	Z1	27/10/76			100	6000	6100				11,264																																			
"	"	"	"	03/11/77			240	380	620																																							

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<sup>1</sup> Location is shown in Figure 1.; N.D. - Not Detected ; P - Present ; < - Refers to less than ; 1 mg/l = 1 ppm = 1 lb / 100,000 Imp. gal ; 1 ppb = 1 µg/l.

APPENDIX H

SUMMARY OF BACTERIOLOGICAL  
ANALYSES OF GROUNDWATER



Ministry of the  
Environment

Ontario

County: GREY-BRUCE

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled d/m/y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
1	Well at north end of sewage lagoon	K	2	21	12/01/76	0	6	0	0	0			
"	"	"	"	"	23/02/76	0	0	0	0				
"	"	"	"	"	29/11/76	< 2	160	< 2	< 2				
"	"	"	"	"	08/03/77	< 2	< 2	< 2	< 2				
"	"	"	"	"	03/11/77	< 4	56	< 4	< 4	< 4			
2	G. Urbshott	K	2	21	15/12/75	0	10	0	0				
"	"	"	"	"	12/01/76	0	0	0	0	0			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

Ontario

County: GREY-BRUCE

Township(s): KEPPEL(K), WIARTON(W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled d/m/y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
2	G. Urbshott	K	2	21	23/02/76	0	0	0	0				
"	"	"	"	"	29/11/76	42	30	8	42				
"	"	"	"	"	08/03/77	42	42	42	42				
3	R. Hellyer - well on east side of house	K	2	21	08/03/77	400	36,000	16,000	108				
3720	J. Campbell	K	3	21	29/11/76	42	42	42	42				

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



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Environment

Ontario

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

County: GREY-BRUCE

Township(s): KEPPEL(K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled d/m/y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
4528	G. Schroeder	K	3	21	29/11/76	<2	4	<2	<2				
"	"	"	"	"	09/11/77	<2	<2	<2	<2	0			
5534	A. Hurlburt (M. Nixon) owner	K	4	21	23/02/76	0	0	0	0				
"	"	"	"	"	27/10/76	<4	<4	<4	<4				
"	"	"	"	"	09/11/76	30	1,900	350	20				

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

Ontario

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL(K), WIARTON(W)

Date Compiled: March 31, 1977 Compiler: C RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled d/m/y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
5534	A. Hurlburt (M. Nixon) owner	K	4	21	29/11/76	<2	<2	<2	<2				
"	"	"	"	"	08/03/77	<2	<2	<2	0	0			
"	"	"	"	"	03/11/77	<2	<4	<4	<2	0			
4	Well in field east of A. Hurlburt	K	4	21	29/11/76	<4	11,000	23,000	68	<2			
"	"	"	"	"	08/03/77	<2	170	<2	200				
"	"	"	"	"	03/11/77	210	44,000	1,800	46	Present			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
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Ontario

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled d/m/y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
5	J. Symon (A. Ward) owner	K	5	21	29/4/76	66	130,000	118,000	78				
"	"	"	"	"	08/03/77	2	1,700	6	2	0			
"	"	"	"	"	03/11/77	42	1,300	140	6	0			
6	J. Brown (A. Thompson) owner	K	6	21	29/4/76	36	10,000	7,700	106				
"	"	"	"	"	08/03/77	6	80	10	10	0			
"	"	"	"	"	27/04/77	42	42	42	42				

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

Ontario

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled d m y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
7	G. Cunningham	W			29/11/76	4	620	148	10				
5047	B. Keith	K	7	22	08/03/77	42	1100	6	0	0			

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<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
Spring 1	G. Armstrong - settling tank	K	2	21	24/1/75	44	2,900	52	700				
"	"	"	"	"	15/12/75	4	680	76	0				
"	- captured bedrock spring	"	"	"	12/01/76	44	92	44	44	0			
"	- Kitchen tap	"	"	"	23/02/76	0	0	2	0				
"	"	"	"	"	22/04/76	0	0	0	0				
"	V. Baker - spring	"	"	"	08/03/77	42	42	42	42				
"	G. Armstrong - spring	"	"	"	03/11/77	42	1280	156	42	0			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

Ontario

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
Spring 1a	G. Armstrong -spring	K	2	21	24/11/75	90	9,900	780	360				
"	"	"	"	"	12/01/76	absent	90,000	610	present	absent			
"	"	"	"	"	23/02/76	0	540	70	108				
"	open spring	"	"	"	29/11/76	26	10,000	3200	30				
"	-spring	"	"	"	08/03/77	60	25,000	900	202				
Spring 2	R. Boulter spring	K	4	21	23/02/76	276	3,400	720	340				
"	"	"	"	"	27/10/76	17,000	260,000	300,000	48,000				

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<sup>1</sup> Location is shown in Figure -1 ; < - Refers to less than



# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

County: GREY - BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
Spring 2	R. Boulter Spring	K	4	21	09/11/76	2100	100,000	42,000	860	10			
"	"	"	"	"	29/11/76	660	110,000	146,000	1800				
"	"	"	"	"	08/03/77	64	7,000	6,500	8				
"	"	"	"	"	03/11/77	370	280,000	14,000	10	1			
Spring 3	Spring NW of the Wiarton Sewage Lagoon	K	2	21	15/12/75	144	43,000	3,400	124				

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
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# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

Ontario

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL (K) WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
Spring 4		W			23/11/77	84	10,000	700	140	44			
Spring 6		W			23/11/77	42	480	24	42	0			
Spring 8		W			03/11/77	42	>20,000	178	46	0			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL(K), WIARTON(W)

Date Compiled: March 31, 77 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
9		W			23/11/77	+	3.600	112	8	24			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than

APPENDIX I

SUMMARY OF BACTERIOLOGICAL ANALYSES  
OF STREAM WATER AND SURFACE RUNOFF



Ministry of the  
Environment

Ontario

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
1	Taylor Street Ditch	W			12/01/76	8	4,100	350	44	0			
2	Intermittent Stream on R. Hellyer property	K	2	21	29/11/76	36	560	194	80	42			
"	"	"	"	"	08/03/77	60	19,000	1200	296				
3	Intermittent Stream on B. Thorn property	K	3	21	29/11/76	276	48,000	23,000	208	42			
"	"	"	"	"	08/03/77	52	18,000	2100	368				

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

Ontario

## SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

County: GREY-BRUCE

Township(s): KEPPEL(K), WIARTON(W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
4	Intermittent Stream north of W. Ward on north side of Con. 21 Road	K	5	22	08/03/77	16	500	1400	456				
5	Surface water west side of Lagoon	K	2	21	23/11/77	24	55,000	1,600	1,444	24			
6	Surface water NW of lagoon	K	2	21	23/11/77	8	356	160	8	24			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
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Ontario

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF WATER

Number of bacterial colonies per 100 ml

Southwestern Region

Technical Support Section

985 Adelaide St. South; London N6E 1V3

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
7	Surface Water N.W. of lagoon	K	2	21	03/11/77					Present			
8	Surface water N.E. of lagoon	K	2	21	03/11/77					Present			
9	Surface water N.E. of lagoon	K	2	21	23/11/77	12	2,400	100	16	24			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF SEWAGE LAGOON EFFLUENT

Number of bacterial colonies per 100 ml

Ontario

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
10	Surface water S.E. of Lagoon	K	2	21	23/11/77	44	55,000	1,600	1,444	44			

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<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



# SUMMARY OF BACTERIOLOGICAL ANALYSES OF FEEDLOT RUNOFF

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
1	Well pit W. Ward	K	5	21	29/11/76	484	11,200	6300	440	22			

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than

APPENDIX J

SUMMARY OF BACTERIOLOGICAL ANALYSES  
OF SEWAGE LAGOON EFFLUENT



## SUMMARY OF BACTERIOLOGICAL ANALYSES OF SEWAGE LAGOON EFFLUENT

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. REDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
1	Warton Sewage Lagoon Cell #1	K	2	21	12/01/76	35,000	800,000	780,000	23,000	430			
"	"	"	"	"	23/02/76	240,000	6,400,000	1,490,000	42,000				
"	"	"	"	"	08/03/77	420,000	3,500,000	980,000	19,100	3,000			
"	"	"	"	"	03/11/77					Present			
2	Warton Sewage Lagoon-final effluent	K	2	21	23/02/76	480,000	3,000,000	2,100,000	13,000				

<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than



Ministry of the  
Environment

Ontario

# SUMMARY OF BACTERIOLOGICAL ANALYSES OF SEWAGE LAGOON EFFLUENT

Number of bacterial colonies per 100 ml

County: GREY-BRUCE

Township(s): KEPPEL (K), WIARTON (W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
3	Pumphouse - north of sewage lagoon - south of Elm Street	K	2	21	12/01/76	860,000	23,000,000	5,800,000	290,000	9,300			

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<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than

APPENDIX K

SUMMARY OF BACTERIOLOGICAL  
ANALYSES OF FEEDLOT RUNOFF



# SUMMARY OF BACTERIOLOGICAL ANALYSES OF FEEDLOT RUNOFF

Number of bacterial colonies per 100 ml

Ontario

County: GREY-BRUCE

Township(s): KEPPEL(K) - WIARTON(W)

Date Compiled: March 31, 1977 Compiler: C. RIEDIGER

Identification Number <sup>1</sup>	Owner or Source	Location			Date Sampled D/M/Y	Fecal Coliform Bacteria	Background Bacteria	Coliform Bacteria	Fecal Streptococci Bacteria	<u>Pseudomonas</u> <u>aeruginosa</u>	Sulphate Reducing Bacteria	Heterotrophic Bacteria	
		Township	Lot	Concession									
1	From open Silo - R. Boulter farm	K	4	Z1	09/11/76	16,700	4,400,000	350,000	9,600,000				
"	"	"	"	"	03/11/77					Present			
2	From feedlot W. Ward	K	5	Z1	27/10/76	inconclusive result	16,000	800	50,000				
"	"	"	"	"	03/11/77					Present			
"	"	"	"	"	23/11/77	130,000	40,000,000	40,000,000	11,000,000	inconclusive result			

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<sup>1</sup> Location is shown in Figure 1 ; < - Refers to less than